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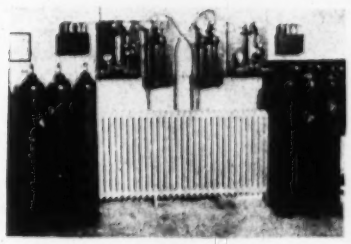
Water Chlorination Problems and Practice



Temperature effects on taste—Corrosion of service pipes and other metals—Shall we depend on chlorine or filtration for bacterial efficiency? Questions answered by water-works operators from New York to the Philippines, and from Minneapolis to St. Louis and the Panama Canal Zone.

Other Articles of Interest to Water-Works Men

Use of Photography in Hydraulic Measurements in India —*By S. C. Majumdar.*

Repairing Wood Water Conduit at Norfolk, Virginia —*By J. W. Ledoux.*

Cost of Anti-Malaria Work in Port Arthur, Texas —*By R. G. Upton.*

Water-Works Cross-Connections at Hartford, Conn.; Report by George W. Goethals Corporation.

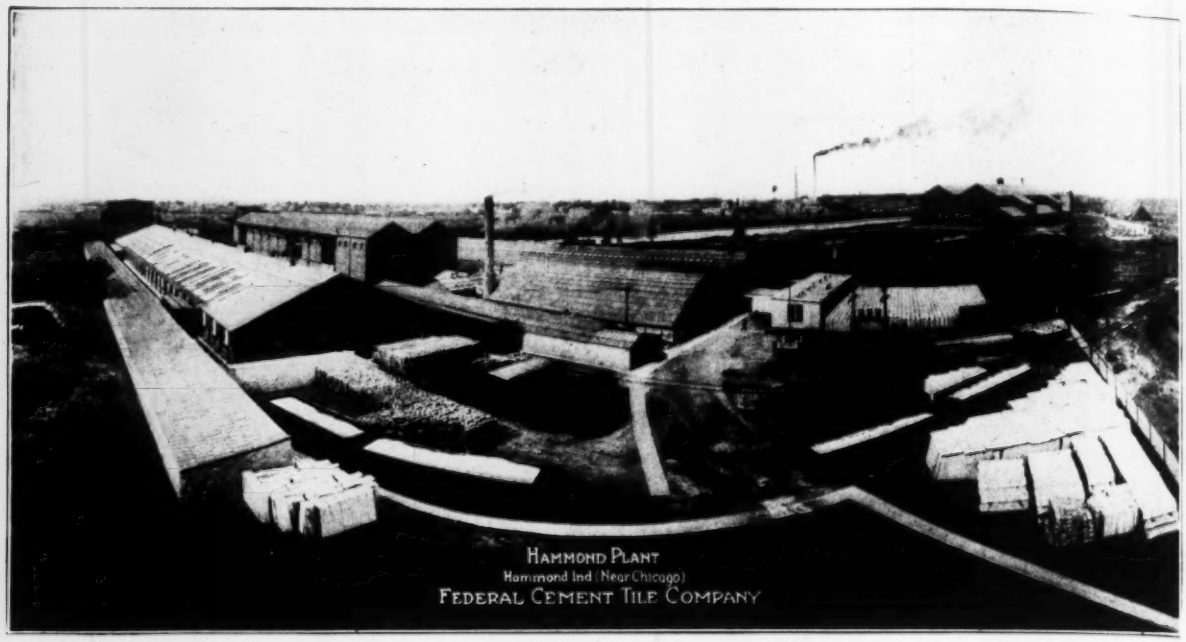
Mechanical Filtration Plant Being Built in Cambridge —*By George A. Johnson.*

Underground Water Supply for an Akron Rubber Plant —*By Frederick L. Roache.*

Also In This Issue

A 30-Ft. Waterway from Ontario to the Sea

Report of the Government Engineers—Col. W. P. Wooten, Corps of Engineers, U.S.A. and W. A. Bowden, Chief Engineer, Canadian Department of Railways and Canals—on the engineering features and cost estimate of a possible navigation and power development on the St. Lawrence River.



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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

Volume 87 — NEW YORK, SEPTEMBER 8, 1921 — Number 10

This Week and Next

CONSIDERABLE space is given to water-works articles in this issue because of the convention of the New England Water Works Association at Bridgeport next week. The summary of chlorination experience and views drawn from 17 chemists and filter plant operators will be concluded next week. Not distantly related to the water-works articles, either geographically or by subject, is the abstract of the St. Lawrence Waterways report to which several pages of text and a large folding insert are devoted, while an article on hydraulic measurements by photography will appeal directly to many water-works men.

Wood Water Pipe at Norfolk

THOUGHTLESS people might consider the Norfolk experience with a 24-in. machine-banded wood-stave pressure pipe line, described elsewhere in this issue, as a condemnation of that sort of conduit. Quite the contrary is the case. The lesson is that here is a material and type of construction, low in unit cost of carrying capacity, flexible in design and construction, capable of mishandling then and in operation, but adapted to repair when through mishandling things go wrong. Mr. Ledoux's article is notable because of this lesson and as a description of a unique job of restoring to use an engineering structure that might have been looked upon in utter despair. Testimony to Norfolk's faith in wood pipe is the fact that it has but recently let a contract for some ten miles additional of yet larger pipe, 30- and 36-in., also under pressure.

How the Product Is Made

IN A RECENT bulletin the National Paving Brick Manufacturers' Association expresses the wish that every engineer and public official might find time to visit a paving-brick plant in its operating hours. It contends that the time would be well spent by the visitor and it is frank to say that the paving-brick manufacturer would profit from the time that he would contribute as guide and host. It would be a reflection upon the intelligence of engineers and contractors to argue the case in favor of careful inspection, and even study, of the manufacturing processes by which construction materials are produced. Nevertheless, the experience of manufacturers is that relatively few of their customers interest themselves in the operations by which the materials are made available. Buyers know what these processes are in a general way, but, lacking acquaintance with details, are unacquainted with the factors that go to make a good or a bad product. We do not mean that one must be thoroughly familiar with manufacturing processes to be able to specify a proper material, but we do believe the joint interest of user and producer would be served by more familiarity on the part of the user with the manufacturing processes. The corollary, of course, also holds—that the producer should know the conditions of use. Many efforts toward securing this mutual understanding have been made, the greatest being the continual efforts of the American Society for Testing Materials. These efforts would be much furthered if the thought expressed by the National Paving Brick Manufacturers' Association were more often acted upon—that engineers and contractors and public officials would visit brick plants and the establishments of other producers of materials as well.

A Suggested St. Lawrence Plan

THERE are many variations possible in the physical details of canalizing the St. Lawrence for ocean-steamer traffic, at the same time utilizing for power the fall developed. One of these—with minor alternatives—is presented in the Wooten-Bowden report abstracted in this issue. It is not necessarily the scheme that will have to be followed if the project goes through, but it does give some line on the costs involved and the magnitude of the proposed engineering operations. As such it provides a datum from which consideration of the merits of the St. Lawrence plant can start with more accuracy that in the past, when there was not available an unbiased estimated of cost or a tentative physical plan. The International Joint Commission will in a short time submit the data in the other elements of the proposition, that is the commercial possibilities, the financial complications and the international obligations. With all the facts before the country the St. Lawrence development can then be argued out.

Dr. Houston and B. Welchii

SIR ALEXANDER HOUSTON, director of water examinations, Metropolitan Water Board, London, England, has written an article for *Engineering News-Record*—to appear Sept. 22—which is a most valuable supplement to the discussion in our issues of June 2 and 9 of B. Welchii as a test of the sanitary quality of water and as a possible cause of gastro-enteric and diarrheal outbreaks. The article contains trenchant remarks on chlorination and on slow sand and mechanical filtration. The 66 contributors to the discussion of B. Welchii in our issues of June 2 and 9 made such frequent reference to the work and opinions of Dr. Houston that they and all others interested in water supply will welcome his review of this important question.

When Are Construction Conditions Good?

FOR the first time this year the value of contracts let during any one month, as reported in *Engineering News-Record*, has exceeded the amount recorded during the corresponding month of 1920. During August the value was in excess of $106,000,000 as against $92,000,-

000 for August 1920. The year 1920 was considered a good construction year, so a comparison of the two years should be fair as indicating present construction conditions. It is apparent, however, that during 1920 a large amount of holdover highway work kept many busy. Such activity was not reflected in the contracts recorded as let last year. Again, industrial work last year was very active. This year it is not. On the other hand much private work is now being done under the general classification of miscellaneous building. About half the total contract value for the past month was in that class of work. And highway work in August was fifty per cent greater than August of last year. Why then, with these figures at hand, is the construction industry so depressed? Is it because the contracts are absorbed by the smaller contractors, from whom it is more difficult to secure business information? It is the common word among the large contracting organizations that conditions are bad. Why, with so much work being put under contract are they bad? Are contractors basing their judgment of "a good year" upon the remembrance of war contracts that ran into many millions? Someone is getting the contracts, doing the work, and profiting thereby. In view of the figures on contracts let contained herein, it is difficult to see why conditions are as bad as reported.

Dangerous Cross-Connections

THE case for cross-connection between safe public water supplies and dangerously polluted private supplies is presented elsewhere in this issue in the Goethals corporation's report to a committee of Hartford manufacturers. The report, which for the most part discusses the problem in general terms, should be read in connection with the one of the same subject by C. M. Saville, manager and chief engineer of the Hartford water-works, printed in our issue of July 7, p. 12, wherein specific evidence against cross-connections based on Hartford conditions and experiences is given. The Hartford Water Commissioners have not only stood by their guns in refusing to rescind or modify their order—except in postponing the date it becomes effective—but they and their engineer appear also to have won over the manufacturers to an appreciation of the reasonableness of the order and a willingness to obey it. This is creditable to all concerned. Hartford's achievement promises to aid in the widespread campaign for the severance of all physical connections between public supplies made safe at great expense and dangerous private water supplies selected with no regard except cheapness. It will also give support to those water and health authorities who for the present feel all they can hope to attain is the material but imperfect protection afforded by substituting readily accessible, frequently inspected double check valves for old-fashioned, buried-no-one-knows-where single check valves.

Letting Contracts Now

FALL LETTING of highway contracts has been urged upon state road-building organizations by the Secretary of Commerce. Avoidance of a further increase in unemployment, amelioration of present conditions, and a better spreading of the construction load are chief among Mr. Hoover's reasons for addressing his recent letter to the state governors. His arguments apply equally well to all classes of construction. In fact, they are more pertinent as applied to building work than to other types, for that can go on in cold weather. Fall letting for buildings means work this winter, when we will most need it, while fall letting for road, sewer, water and similar works is principally preparation for an earlier start in the spring. Objection to letting contracts now may be raised on the ground that the falling market indicates further decreases, and that those who invest now will lose. A job thoroughly planned and carefully executed without interruptions will be inexpensive in comparison with the job that is held up because of transportation congestion, scarcity or lack of materials, difficulty of getting labor, or failure of equipment to arrive in time. Winter construction is relatively certain of being free from these difficulties, while work let now for spring execution can get well ahead by carrying on demolition in winter, stockpiling materials and getting equipment on the job. The advantages give promise of counterbalancing what price reductions are likely to occur. Prices now, in fact, seem to be tending toward stabilization.

Problems in Water Chlorination

WHILE questionnaires and symposiums cannot take the place of accurate scientific laboratory tests and field observations, the collection of such data as is available from different parts of the country will always serve as a starting point for further investigation. Moreover, it will prevent useless duplication.

Many apparently conflicting statements have been made with reference to experiences with liquid chlorine when used to eliminate bacteria from drinking water. Bringing data and opinion together, as is done elsewhere in this issue, enables one to explain the reasons why conflicts are found. Briefly, it is because of the different characteristics of dissolved and suspended foreign matter in drinking water. Most of the substances other than H_2O react with chlorine, some of them forming disagreeable compounds. Few people ever get from drinking water the acid taste of real laboratory chlorine. Furthermore, the creosote-chlorine taste formerly experienced in Milwaukee is not to be compared with an algae-chlorine or colored-water-chlorine taste. Some waters are nearly neutral and a slight addition of the acid-producing chlorine gives the water acid characteristics. The great bulk of our waters, however, are far too alkaline to make the slight addition of chlorine a disturbing factor.

In preparing the questionnaire, we first had in mind asking about the effect of water with residual chlorine on the lining of the kidneys. We could not learn, however, that even the doctors had made any studies, and therefore abandoned the idea of burdening the questionnaire with a query to which practically every one would have had to confess at least comparative ignorance.

Some of the conclusions one reaches on reading the answers to the questionnaire are as follows: (1) Cold water troubles are due far more, probably, to other factors than chlorine, although cold slows up the chemical reaction and theoretically should make a smaller dose permissible if the taste limit had been nearly reached. (2) People do become accustomed to slight tastes and odors or else get tired of complaining. (3) No limit can be set on the amount of residual chlorine which will produce tastes. (4) A well water with 0.01 p.p.m

may taste and a surface water with 0.8 p.p.m. may not. (5) With one or two exceptions corrosion has not been experienced. (6) The operators are about equally divided on the expediency of holding to the highest standard of filter efficiency rather than getting clarification only and bacterial control with chlorine. (7) Aiming at the Public Health Service standard is desirable but not necessary. (8) After certain limits—up to 600 to 1,000 units per c.c.—an algae-infested water requires more chlorine.

Finally one concludes that chlorination has come to stay as a most valuable health guard, and that the slight inconveniences and complications are far outweighted by the added safety factor placed in the hands of the operator.

Water-Works Progress and Opportunity at Cambridge, Mass.

MASSACHUSETTS cities have been slow to adopt any method of water treatment, except that incidental to storage or required for the removal of iron from ground water. This has been due in no small part to topographical and geological conditions favoring the introduction and maintenance of supplies of high natural quality. To this has been added early and persistent efforts by the State Board of Health and by municipalities to prevent dangerous water pollution and, where it could no longer be avoided in the case of existing supply, to go far afield, if need be, for new and relatively safe source. Where filtration has been adopted, it has heretofore been of the slow sand type, except in the case of iron removal, for which mechanical filters have been used. Chlorination has been little used in the state.

All these things make noteworthy the mechanical filtration and chlorination plant now being built for Cambridge, Mass., as described elsewhere in this issue. This plant is all the more notable because for years past Cambridge has had one of the lowest typhoid death rates in the country; but it should be added that freedom from typhoid did not protect Cambridge, early in 1920, from one of those mysterious outbreaks of intestinal troubles that have occurred of late in several cities having water supplies of good reputation. If this outbreak did not hasten the determination of the city to build a complete water-treatment plant, it must certainly have made the city fathers feel more sure than ever that the money for the plant will be well spent. And yet it will not be surprising if the vital statistics of Cambridge reflect little effect from the purification works after they are put in use. The typhoid rate there has long been so low as to give little hope from any further reduction on account of filtration.

In view of this, the water and health authorities of Cambridge might well give immediate and searching attention to studies of the water supply and of the vital statistics designed to show the beneficial effect of water treatment on causes of death and sickness other than typhoid. To urge this is not to question the wisdom of water treatment for Cambridge but rather to encourage the amassing of data that will show the exact nature and extent of the benefits flowing from a water supply as nearly ideal as engineers can make it, while at the same time throwing much needed light on some of the unsolved problems connected with intestinal outbreaks attributed, rightly or wrongly, to public water supplies. Cambridge's local progress gives it opportunity for world-wide service.

Unemployment

THAT part of Gompers' address at Atlantic City last month in which he enlarges on unemployment is worthy of serious consideration. It points to the need for every agency that can influence costs and help to stabilize business to do all in its power. Not the least, however, of those who can influence the situation is Mr. Gompers and his influential assistants in the American Federation of Labor.

Mr. Gompers gives the total of unemployment as 5,700,000. It should be remembered, though, that the Department of Labor in giving out the statistics which Gompers quotes, pointed out that the comparison was with the peak of last year's employment, and that the demand for workers at the peak last year brought into employed ranks many women, girls, and boys who are not normally in the employed ranks. By what amount these factors would reduce the alleged "unemployed figures" the department does not say. Probably it would be a considerable percentage. Moreover, "normal" unemployment, statistics show, runs from 2,000,000 to 3,000,000, being lowest in the late summer.

Even so, however, there is good reason to be thinking about our unemployment. It is large, no matter what the off-sets. The immediate situation, too, is not so serious as that which we will find in the winter if unemployment on the present scale continues. It is to this that Gompers is looking forward. Now there is relatively little distress, but winter brings the need for watertight shoes, warm clothing, and coal.

We are all in hopes of a sharp pick-up between now and Christmas. There are many signs that it is on the way. It can be hastened if every one will do business on a narrower margin and by the workers giving full efficiency. In the construction industry, for example, if the workers can carry to owners, contractors, engineers, and architects the confidence that there will be 100 cents' worth of honest work for every $1 of wage payment, it will stimulate the constantly rising curve of construction work—even in fact of the approaching cold weather. The records kept by *Engineering News-Record* show a constant increase month by month in bids invited and contracts let this year. The August totals, in fact, exceed those of last year. High costs, however, still hold work back—and of these not the least is high labor *cost*. Note that we say labor *cost*, not *wage*. High *wages* are not incompatible with low costs.

What is true in the construction industry is true also in every line.

Of course, output per man is now very much better than it was last year. Some say it is near the pre-war normal. Where the chief room still lies for improvement is in the abrogation of many of the restrictive union rules. Right there Mr. Gompers and his associates are in a position to have a tremendous influence.

There is practically no hope of changing these rules by advice or by force from the outside.

Therefore, while the outlook causes concern and while there are many factors that can influence the situation, Mr. Gompers is in a position—better than any other man—to help stimulate business and thus reduce unemployment.

Problems in the Chlorination of Water—I.

Seventeen Water-Works Operators Give Experience on the Effect of Temperature on Tastes and Odors Corrosion of Metals and Efficiency Factors

Chlorination of public water supplies having come to stay, it is necessary to go to the bottom of all of the problems which the process brings to the operator. Does chlorine cause more tastes in summer or winter? In malarial countries the use of quinine, one of the bitterest and least palatable of drugs, becomes a habit for which a craving develops. Do people get so accustomed to chlorine tastes as not to notice the "medicinal" flavor? It is too much to expect that they will ever crave it as do the quinine addicts. Perhaps they get tired of complaining and we assume that they like it. Anyway, to the ordinary tongue what is the limiting dose which does not produce a noticeable taste? How about the numerous rumors, a few substantiated, too, of metal corrosion? Then there is the old question of the extent to which chlorination should take the place of filtration. Should plant operators strive less to produce a low bacterial count by filtration, relying on chlorine for that, and try to get 100 per cent clarification as economically as possible? The operator cannot brush the question aside lightly as being fostered on one side by the consulting engineers who want to design and build filters and on the other by sellers of chlorine apparatus. The consumer is the first consideration of the operator. He must continually balance the public health against the form and economy of treatment. He is on the firing line and gets a reaction quickly if this product does not keep pace with the continually increasing standards which the widespread health education of the masses demands.

In view of all these considerations ENGINEERING NEWS-RECORD *decided to ask operators of typical plants to tell of their experience along these lines—tastes, metal attacks and efficiency factors. As was to be expected, agreement was not obtained on any one of the eleven questions asked. However, sufficient light was shown to settle certain points as much as they can ever be settled when taking into account (1) the varied character of water over the country and (2) the unstable and variable characteristics of the chlorine combinations made with the water-borne materials.*

Nineteen answers were received but from two no information bearing on the subject was obtained. Springfield, Mass., says E. E. Lockridge, chief engineer of water-works, has been able to secure from its slow sand filtration plant results fully equal to those given by the chlorine experts. Charles P. Hoover, chemist of the filtration plant at Columbus, Ohio, depends on lime causticity for sterilization, using chlorine as a precautionary treatment only and cutting it out when contained organic matter is high and chlorine produces a taste.—EDITOR.

Temperature and Tastes and Odors

TASTES and odors cannot be measured in the laboratory. They are almost intangible, yet decidedly affect the esteem in which the consumer regards a water. It was felt therefore, that a widespread experience as to tastes in summer and winter would add to the known laboratory facts relative to the effect of low temperatures in slowing up chemical reactions. Knowing that the public verdict on any subject is large psychological and influenced by propaganda, prevailing opinion and style, a question was asked to bring out the persistency or not of complaints. Definitely then, the opinion as to maximum quantities permissible was sought. The three questions and answers which follow indicate decidedly divided opinion on the public's verdict and no agreement on the limiting amounts that may be used. Quality factors apparently are far more decisive than varying amounts of chlorine dosage.

1. *What troubles have you experienced in the chlorination of water supplies due to different temperatures? Have you had more trouble in cold weather than in warm weather after a given amount of chlorine has been applied?*

2. *Does the public become accustomed to the tastes and odors in chlorinated water so that complaints are less frequent after a supply has been treated for a long period?*

3. *What is the maximum amount of free chlorine permissible?*

J. S. Gettrust, Superintendent of Filtration, Akron, Ohio.—1. No trouble. 2. Experience elsewhere indicates that the public does not get accustomed to them if they are intermittent. 3. Varies with different waters. Akron water frequently contains 0.15 p.p.m. without taste or odor.

J. W. Ellms, Consulting Engineer and in charge of the Cleveland rapid filters.—1. Chlorination is more easily brought about in cold water than in warm water. This is in line with the well-known fact that all gases are more readily dissolved in cold water than in warm. Smaller doses have more bactericidal effect in cold weather than in warm. More free chlorine appears to be present in very cold water treated with this disinfecting agent than in warm water. This would seem to indicate that a longer time is necessary to complete the reactions taking place, which fact is, of course, in line with the effect temperature has upon the velocity of reactions. Experiments made some years ago by the writer showed that bacterial multiplication was prevented so long as free chlorine was present. The bactericidal effect of chlorine has been explained as a poisoning of the cell by adsorbed gas. What complex reactions may follow are, of course, problematical. However, the chlorine, or the hypochlorous acid which may be formed from it, eventually disappears as such. Whether these reactions, because of the energy liberated, are sufficient to account for the killing of some or all of the bacteria, or whether it is a case of poisoning, it is impossible to state with our present knowledge.

2. Consumers may become accustomed to slight tastes due to the use of chlorine, but it is doubtful if they ever do or will tolerate very marked tastes lasting for even a few days. Moreover, one must carefully distinguish between the real primary causes for obnoxious tastes and odors. If the chlorine itself, because of the quantity used, is the cause, the remedy lies in part in the hands of the water-works officials. If the water is infested with microorganisms, either living or dead, or with dead organic matter, suspended or dissolved, possible remedies may also be found in filtration. Where the cause is due to trade-waste pollution, especially the kind of wastes derived from by-

product coke ovens and gas plants, the remedy lies in preventing such material from entering the water supply. The writer's investigations in this latter field have convinced him that where such wastes are the source of the trouble, subsequent chlorination must inevitably produce foul tastes and odors, and that filtration is no remedy. The problem in this case is not one of water purification, but of the proper disposal of trade wastes.

3. The disappearance of free chlorine is in most cases so rapid in a distribution system that the writer doubts if "chlorine tastes" are usually directly caused by this reagent. Probably from 0.4 to 0.6 p.p.m. of chlorine, when first applied, might be detected by taste by the layman, but the actual quantity of excess of chlorine remaining from such an application will vary with the temperature and kind of water treated. Certain kinds of organic matter may combine with the chlorine and be the real cause for the taste, even though no free chlorine be present.

A. E. Walden, Superintendent and Chief Engineer, and S. T. Powell, Chemist, Baltimore County Water and Electric Co., Md.—1. Considerable trouble has been experienced from tastes and odors after chlorination during the colder months of the year. The tastes and odors have invariably been more pronounced when there has been a drop in the temperature of the water. We have been able to apply three or four times as much chlorine during the summer months as in the winter.

2. The public does not become accustomed to tastes and odors in chlorinated water. Complaints become less frequent unless a very unusual amount of the chemical has been used.

3. No definite amount of chlorine in a free state can be designated as a permissible limit for all water supplies, but it is our opinion that it is inadvisable to permit more than 0.25 p.p.m. of free chlorine to exist in the water for more than half an hour.

J. W. Armstrong, Filtration Engineer, Montebello Filters, Baltimore, Md—1. Chlorine is applied to the filtered water at rates varying from 0.22 to 0.6 p.p.m. In summer the water will absorb twice the amount that it will in winter. This is probably due partly to the effect of the cold water and partly to the fact that a larger amount of organic matter prevails in the water during the summer.

2. When we first started the plant a slight chlorine taste in the water would bring numerous complaints, but during the past winter very few complaints were received.

3. Water containing from 0.1 to 0.15 p.p.m. of residual chlorine does not necessarily taste but it is likely to, and we believe that residual chlorine in filtered water should be kept below 0.1 p.p.m. Water leaving the plant fairly high in residual chlorine will, after traversing four miles of pipe, show a considerably reduced amount, and after about eight miles of travel there is very rarely any residual chlorine left.

S. Van Loan, Deputy Chief, Bureau of Water, Philadelphia, Pa.—1 and 2. No trouble. 3. Impracticable to fix a standard, as amount varies with character of the water and distance to delivery point.

Dr. Frank E. Hale, Director of Laboratories, Department of Water Supply, Gas and Electricity, New York City.—1. Complaints from taste with regard to New York City's supplies have not been connected with temperature, but rather with fluctuations in dosage. The greater portion of our supplies passes through reservoirs of sufficient storage capacity to eliminate any large excess of chlorine, and furthermore, the dosage is so low, averaging usually from 0.1 to 0.2 p. p. m., that there is very little excess in the supply at any time. Orthotoluidine tests indicate less than 0.05 residual free chlorine. From experiments with chloramine and bleach (see *Journal* American Water Works Association, November, 1919, p. 804), temperature has no noticeable connection with the amount of chlorine dosage required for given results; i.e., under the same conditions as to turbidity, color, organic content, microscopic organisms, amount of B. Coli or contamination present, the same dosage of chlorine will produce the same efficiency, winter or summer. The dosage applied has varied from winter to summer at different plants and in different years at the same plant. At the Dunwoodie plant during 1916-17 the dosage was approximately the same winter and summer, but during 1919-20 the dosage was larger in the winter and fall months than in the summer months. On the other hand, dosage at the Phoenicia plant has been greater in the summer than in the winter, and in the Bronx pipe line about the same the year around. At the Dunwoodie plant the gas is introduced to the water through diffusers. In cold weather chlorhydrate forms and clogs the diffusers so that they have to be removed and allowed to stand in a warm place until the chlor-hydrate evaporates.

2. It is a question whether consumers have become accustomed to taste and odor, or whether they have become tired of complaining. In large measure the amount of complaint depends upon whether the supply is from surface sources or from ground sources, people who have been accustomed to well supplies noticing particularly any change. Such complaints have been occasioned not only by chlorination, but by a change from well water to surface water, and *vice-versa*. Even after becoming accustomed to the change, people complain if, by accident, an over-dose is applied, or the chlorinated water goes directly to the consumer without passing through a storage reservoir.

3. The maximum amount of free residual chlorine permissible would depend largely upon whether it was from surface or ground sources. It also depends largely upon various organic constituents in the water supply, such as essential oils of microscopic organisms and tarry matters taken up from pipe coatings. I have received complaints from well water which had been treated with only 0.1 p.p.m. chlorine and have personally been able to notice a slight odor of chlorine when the orthotoluidine test indicated a residual free chlorine of only 0.01 p.p.m. On the other hand, I have introduced bleach to a surface water to the extent of 0.8 p.p.m. available chlorine without being able to detect the odor immediately after the mixture was made.

The J. N. Chester Engineers, Consulting Engineers, Pittsburgh, Pa., sent the list of questions to several plants which they operate. The consensus of opinion culled from the information thus obtained together with personal observations is reported by J. F. Laboon.—1. It is more difficult to control the dose in winter than in summer and most of the taste troubles we have found have been due to overdosing during the cold months of the year. It is necessary to reduce the dose during the winter months to prevent excessive taste, although our bacterial results have been satisfactory at these times.

2. Consumers are ever ready to complain when a chlorine taste develops and we cannot say that they ever become accustomed to it, although we have observed that they do not notice so readily an overdose as in previous years.

3. We try not to apply a greater amount of chlorine than would produce a slight excess as indicated by the orthotoluidine test. This is one of the rules we set up in our plants as a guide for absolute sufficiency of dose.

H. E. Jordan, Superintendent Filtration, Indianapolis Water Co.—1. If there is a seasonal difference in difficulties as to the use of chlorine, the difficulties are greater in winter than in summer. Our tendency is, however, to attempt to use more chlorine in the winter than in the summer, so that we probably treat closer to the taste-producing limit at that time.

2. I do not believe that the Indianapolis water supply has a taste of chlorine; neither do I believe that any water supply, which to make satisfactory bacterial reduction must be treated with excessive amounts of chlorine, should be used without modifications of the production process to eliminate the load upon that (the chlorine) portion of the treating plant.

3. There is no reason to chlorinate a public water supply to such an extent as to have a continuous excess of free chlorine in the treated water.

R. S. Buzzell, Chief Chemist, Filtration Plant, Flint, Mich.—1. Cold water is a favorable factor in eliminating tastes when organic color or "hay tea" is present to an amount likely to give rise to a bad taste in water of summer temperature. If the chlorine application is constant in both cases, it does not increase the disagreeable taste in water

of high temperature. Our complaints occur at times of the natural rise of color and not from chlorine.

2. A filtered water of low color and naturally free of tastes, moderately hard, given a proper and reasonable chlorine application, should be agreeable to the taste. We have rarely had complaints arising from chlorine treatment, but I do not believe one can get used to a water having a disagreeable or "medicine" taste, usually due to an overdose of chlorine.

3. The permissible free chlorine is certainly a local problem. Some waters can carry a greater amount than others, and the taste will still be agreeable.

H. P. Bohmann, Superintendent Water-Works and Water Purification, submitted answers prepared by R. L. Piper, Chemist, Water Department.—1. Lower temperatures retard chemical action so that smaller amounts of chlorine combine with the organic matter and bacteria. This leads to the use of smaller doses so as to avoid a large excess of free chlorine. 2. No. The public is more sensitive after several occasions of taste. Complaints are more numerous as the people sometimes imagine tastes when there are none. 3. 0.08 p.p.m.

August V. Graf, Chief Chemist, Filter Plant, St. Louis, Mo.—1. Trouble from tastes occur at times of spring and fall turnovers if more than 1 lb. per m.g. is used, but chlorine is rarely applied in an amount less than 2 lb. No free chlorine is present when complaints of taste are received. No trouble is experienced during the winter with 0.03 p.p.m. of free chlorine in treated water. 2. No. 3. 0.5 p.p.m.

Lewis I. Birdsall, Superintendent of Filtration, Minneapolis, Minn.—1. No trouble. 2. Do not know. 3. Would suggest 0.1 p.p.m.

Dr. Ray R. LaCroix, Chief Chemist, Board of Water Commissioners, Denver, Col.—1. We have no trouble with different temperatures because we reduce the amount of chlorine going into the water as soon as the temperature drops coincident with which drop the bacteria decrease. 2. Yes. The public does become accustomed to the tastes and odors in chlorinated water. However, we endeavor to keep within a certain limit which does not become noticeable.

C. G. Gillespie, Resident Engineer, Filtration Division, Sacramento, Cal.—1. Have noticed invariably more persistent and far-reaching chlorine tastes in cold than in warm weather, except in waters subject to algae and organic pollution. These latter factors have even a more controlling influence in imparting a sustained taste.

2. There is no question but that one becomes accustomed to chlorine tastes if they are not too pronounced. I have observed the taste in the home supply most after returning from an extended absence.

3. At Sacramento during the winter 0.07 p.p.m. residual chlorine at the station is needed for disinfection, but tests for free chlorine are negative uptown and yet tastes are noticed.

George H. Wilhelm, General Manager, East Bay Water Co., Oakland, Cal., submitted answers prepared by P. I. Daniels.—1. We have had no difficulty in this respect, as the temperature in this district probably does not vary sufficiently to cause any trouble. We introduce a slightly larger dose of chlorine in the winter on account of the increased turbidity of the water. 2. We do not dose the water in excessive amounts, so cannot say. 3. It does not seem reasonable that there should be any amount of chlorine in the free state left in the water. If the water has been thoroughly filtered I can see no reason for free chlorine.

George C. Bunker, Physiologist to the Panama Canal in Charge of Water Purification on Canal Zone.—2. No. The most which may be expected is passive submission during emergencies such as an epidemic or pending the installation of filters. 3. Varies. On the Canal Zone 0.02 p.p.m. of residual chlorine will not cause complaint.

Elmer D. Merrill, Director, Bureau of Science, reporting to A. Gideon, Manager, Metropolitan Water District, Manila, P. I.—1. The temperature variation in the local water supply is very slight and once the correct amount of chlorine to be added is definitely fixed, no trouble has been experienced in the process of chlorination.

2. Chlorine treatment, if properly administered and strictly controlled, would leave only small traces of chlorine in the treated water. Our experience in the Philippines has shown that the taste and odor imparted by chlorine is so slight when it reaches the consumer as to give no cause for complaint. Mr. Gideon says: "We had a few complaints when I started the calcium hypochlorite treatment in 1910 but none since that time. I suppose the people got accustomed to the very slight chlorine odor. We use a solution of 1 to 1,600,000 of free chlorine to water by weight, and on several occasions when we tried to increase the ratio, complaints of tastes and odors were received.

3. In the case of the water supply of the city of Manila, no measurements have been made of the exact quantity of free chlorine present in treated water. However, the amount of 0.625 p.p.m. of chlorine is about the maximum that could safely be used without imparting a disagreeable taste and odor to the water.

Attacks of Chlorinated Water on Metals

With a few exceptions chlorine in bactericidal quantities has not been found to attack metals. Apparently Mr. Walden has a water so nearly neutral that the small amount of chlorine makes it acid and in consequence he has corrosion troubles. Mr. Laboon reported difficulty at Jefferson, Mo., with meters, when hypochlorite was used, and Mr. Gillespie indicates difficulty with valve bonnets where chlorine is applied under suction. (See *Engineering News-Record*, July 15, 1920, p. 127). Most of the answers were brief and are included in the following table. All of those answering "yes" to Question 6, excepting Walden and Powell, apparently referred to more concentrated solutions than are commonly employed in water disinfec-

OPINIONS AS TO ATTACKS OF CHLORINATED WATER ON METALS

Operator	Q. 4. Is Chlorinated Water Acid by P'_H Indicator	Q. 5. Increased Corrosion Service Pipes	Q. 6. Other Metals Attacked	Q. 7. Bronze Attacked	Q. 8. Boilers, Etc., Pitted
Gettrust	No	No	No trouble	No	No
Ellms	Doubtful	No	Yes—Dry tin	None reported	None reported
Walden and Powell	Yes, Brom-Thymol Blue	Yes	Yes	Yes	Yes
Armstrong	No change, Brom-Thymol Blue	.....	.....	.....	.....
Van Loan	Phila. H_2O. Always Alkaline	No	Yes	No	No
Hale	No change	No effect	Yes	No complaints	No complaints
Laboon	No	Sl. if any	Sl.	Sl.	No complaints
Jordan	Not Mid-West Waters	No	No	No	No
Buzzell	.....	No	No	No	No
Bohmann	Yes, if near neutral point, Phenolphthalein	No	Yes	No	No
Graf	No. Phenolphthalein	No	No	No	No
Birdsall	.....	No	.....	No	No complaints
LaCroix	.....	No	Yes—Copper	Yes	No complaints
Gillespie	.....	.....	.....	Yes—Valve stems and bonnets	.....
Wilhelm	.....	No	Yes—in excess	No	No
Bunker	No. Phenol red	No	No	No	No
Merrill	No.—Dimethyl-amido-azo-benzol	No	No	No complaints	No complaints

The condensed answers in the table were deduced from extended replies, and in a few cases were qualified. (See text following).

tion. The question was intended to refer to the extremely weak solution of waters with residual chlorine remaining after treatment. The five questions and the few extended comments follow:

4. *a. Does the hydrogen-ion concentration fall on the acid side of the scale in chlorinated water? b. Specify indicator. c. Does this happen if no free chlorine is present in the supply?*

5. *Has the increased corrosion in water pipes, both hot and cold services, been noted after chlorination of the water supply?*

6. *Does the chlorine attack metals other than iron and steel and if so, what?*

7. *What effect has been reported on bronze parts such as valve springs, seats, impellers, boiler attachments, etc.?*

8. *Has there been any report on damage to turbine blades and nozzles in power plants? Or pitting of boilers in steam plants? Or damage to range boilers in residences?*

Mr. Gettrust—5. Corrosion from CO_2 present in waters coagulated with alum might erroneously cause chlorine to be suspected.

Mr. Ellms—4. Because of the small amount of chlorine usually applied an increase in hydrogen-ion concentration seems doubtful. When chlorine is applied to water, two reactions probably occur:

$$a.\quad Cl_2 + H_2O \rightleftarrows HCl + HOCl$$

$$b.\quad 2\,HOCl \rightleftarrows 2\,HCl + O_2$$

The first equation by no means completes itself immediately, and may account for the residual "free chlorine" usually found, although the hypochlorous acid (*HOCl*) would react similarly.

It is certain that the dissociation of the *HCl* would furnish an increase in the *H* ions present. If this reacts, as it probably does, almost immediately with the alkaline carbonates usually present, there would be formed calcium and magnesium chlorides and carbonic acid.

$$CaCO_3 + 2\,HCl = CaCl_2 + H_2\,CO_3$$

The carbonic acid dissociation probably takes principally the form of $H+$ and HCO_3 ions. The acid is little dissociated, yet is sufficiently so to indicate its acid character. Experiments by the writer with filtered Lake Erie water using quantities of chlorine ranging from 0.1 to 10.0 p.p.m. produced the following P_H values 18 hours after being treated:

Chlorine Applied, P.P.M.	Excess Chlorine 18 Hours Later, P.P.M.	PH
0	0	7.80
0.1	Tr.	7.75
0.3	0.02	7.70
0.5	0.02	7.70
1.0	0.30	7.60
5.0	2.00	7.40
10.0	7.00	7.20

N.B.—Temperature rose from 49 deg. F. to 72 deg. F. in 18 hours.

The color changes were found to be very gradual, and for quantities of chlorine within the limits usually applied, it is evident that the P_H value is hardly affected more than 0.1. If the entire quantity of chlorine represented by 1 p.p.m. were converted into hydrochloric acid, which in turn reacted with the carbonates to produce free carbonic acid, there would be produced only about 0.6 p.p.m. of this acid.

Applying a recently suggested formula ("Relationship of Hydrogen Ion Concentration of Natural Waters to Carbon Dioxide Content." By R. E. Greenfield and G. C. Baker, *Journal Industrial & Engineering Chemistry*, Oct., 1920):

$$(H+)\ \frac{4\ CO_3 \times 10^{-7}}{(HCO_3)} + 1 \times 10^{-4}$$ where CO_3 = free carbonic acid and HCO_3 = alkalinity in terms of $CaCO_3$.

To determine the P_H value of natural waters, the writer finds that Lake Erie water, with about 1 p.p.m. of free CO_3 and 90 p.p.m. of alkalinity, has a P_H value of 7.84, which is practically the same as the value (7.8) determined colorimetrically. If it is now assumed that to this water 1.0 p.p.m. of chlorine is applied and that by its complete decomposition 0.6 p.p.m. of additional free CO_2 is produced in the water, the calculated reduction in the P_H value would be approximately 0.1. This is not as much of a reduction as was actually found colorimetrically (P_H from 7.8 to 7.6), when applying 1.0 p.p.m. of chlorine. However, in this experiment 30 per cent of the chlorine yet remained after 18 hours, and it is not improbable that in consequence the water was actually a little more "acid"; that is, had a slightly higher hydrogen-ion concentration than that calculated. It will be noted that in none of the experiments made with Lake Erie water was the water rendered acid; i. e., a P_H value of less than 7.0 was not reached. In less alkaline waters this might, however, occur.

Mr. Bohmann—4. Yes, provided the natural alkalinity of the water is less than the amount of acid formed when the chlorine is added. Chlorine added to water always forms hydrochloric acid and liberates oxygen, whether there is any free chlorine present or not.

Messrs. Walden and Powell—4. We have noted invariably that after chlorination the hydrogen-ion concentration falls on the acid side of the scale; the indicator used is brom-thymol-blue. The P_H value has been noted to be as low as 6. Extended experiments carried out to determine this point were made and it was found that the water before chlorination and after filtration has a P_H value of 7.2. After chlorine treatment the P_H fell to 6. The P_H values were determined at the end of three successive days. It appeared that the chlorinated water gradually rose until at the end of the third day the water was again alkaline, showing a value of 7.2, the same as before the water was chlorinated.

6. In the plants of this company there is an indication that chlorine attacks not only iron and steel, but also bronze and admiralty metals.

7 and 8. It has been noted that impellers in turbines have shown very definite corrosion. Slight pitting has occurred in the boilers of one plant, apparently more pronounced after the dose of chlorine was increased.

Mr. Armstrong—4. The hydrogen-ion concentration has been as low as 6.1 for filtered and for chlorinated water, using brom-thymol-blue as indicator. With the tests we have made, there seems to be no appreciable difference in the hydrogen ions in the filtered water before and after the application of chlorine.

Dr. Hale—4. No free acid exists, in my opinion, in the ordinary water supply that has been chlorinated, but the chlorine combines with the alkalinity to form hypochlorite. So-called residual free chlorine is the available oxygen of this hypochlorite. The above is indicated by a reduction in alkalinity accompanying the introduction of liquid chlorine.

5. The amount of chlorine introduced into a supply, ordinarily, is too small to have any effect on corrosion, and if the above opinion regarding the formation of hypochlorite is correct, the only effect upon corrosion would be the addition of an infinitesimal amount of oxygen to the supply.

6. Chlorine is known chemically to attack, in the presence of moisture, practically all metals except silver and possibly lead, but insoluble deposits formed by partial action prevent further corrosion.

7. We are not aware of any complaints of action on bronze parts, such as valve springs, etc., particularly since such opportunity is rare in New York City's experience. We have read of such complaints, however.

8. Complaints have been received of range boilers, but these were in connection with the Catskill supply and are in no way connected with chlorination, in our opinion, since our average dosage last year was 0.07 p.p.m.

Mr. Laboon—4. In one of our plants where the water is treated with lime, generally there is present alkalinity as determined with phenolphthalein, thus indicating the presence of hydroxyl ions, and therefore making the presence of hydrogen ions impossible. This indicates that the hydrogen-ion concentration falls on the non-acid side of the scale. Waters which are acid to phenolphthalein, in other words containing carbon dioxide and other organic acids, would indicate the hydrogen-ion concentration falling on the acid side with chlorination. This would happen, we believe, even if no free chlorine were present.

5. The consensus of opinion of our informers and our own experience dictates that water pipes, both hot and

cold services, are corroded very little, if at all, due to chlorination.

6. Iron and steel seem to be the only metals which are very appreciably affected by chlorinated water, although it is our belief that the other metals are also affected, but to a lesser degree, and the result of the corrosion is not noticeable in a short length of time. The plant at Jefferson City, Mo., experienced considerable difficulty while using hypochlorite of lime due to the corrosion of the brass parts, such as gear trains in water meters. The difficulty has been overcome by the substitution of the electrolytic cell generating chlorine for the hypochlorite.

Mr. Jordan—4. The hydrogen-ion concentration in a chlorinated water should pass toward the acid side in an amount equal to the unbalancing effect of the amount of chlorine added. If the water is sufficiently alkaline, as is the case in the Middle West, the hydrogen-ion concentration will not reach the neutral point, much less the acid.

Mr. Bunker—In the chlorinated waters from three purification plants on the Canal Zone the hydrogen-ion concentrations fall on the alkaline side of the scale with phenol red as an indicator. The following table illustrates this point:

Plant	Hydrogen-Ion Concentration Filtered Water	Chlorinated Water	Residual Chlorine
Mt. Hope	7.2	7.2	0.08
Agua Clara	7.9	7.6	0.06
Miraflores	7.1	7.0	0.24

The following table gives the P_H concentrations of the filtered water prior to chlorination at the Miraflores plant and of the same water after chlorination as drawn from taps on the distribution system.

		Disinfected Water					
	Filtered Water	Hydrogen-Ion Concentration			Residual Chlorine		
Date	Hydrogen-Ion Concentration	Tap No. 1	Tap No. 2	Tap No. 3	Tap No. 1	Tap No. 2	Tap No. 3
Feb. 7	7.1	.....	7.2+	7.2+	....	0.02	0.0
Feb. 8	7.1	.....	7.2+	7.2+	....	0.0	0.0
Feb. 9	7.1	7.1+	.....	7.1+	0.0	.....	0.0
Feb. 10	7.1	7.1+	7.2	7.1+	0.01	0.03	0.0
Feb. 11	7.1	7.1	7.1+	7.2	0.01	0.03	0.0
Feb. 12	7.1	7.1+	.....	7.1+	0.01	....	0.0

An average of 0.378 p.p.m. of chlorine was applied to the filtered water during the period covered by the above table.

7. No action has been observed on the bronze impellers of nine centrifugal pumps through which chlorinated water passes with residual chlorine continually present in amounts ranging from 0.02 to 0.15 p.p.m.

[*Section II on "Efficiency Factors" will appear in the issue of Sept. 8*]

New Hampshire Water Cross-Connection Control

Secondary sources of water supply in New Hampshire are controlled by the State Board of Health under legislation enacted in 1915 and amended in minor features in 1919. The law gives the board full control of all emergency intakes and also of all cross-connections between secondary and city supplies. When it is necessary to resort to an emergency supply not already approved by the board, notice to that effect must be sent to the board immediately. The board requires double check valves of the Factory Mutual type, "where practicable," we are informed by Charles D. Howard, chief chemist of the board, on all cross-connections between industrial and public water-supplies. "Since 1915," Dr. Howard states, "a considerable number of these installations have been effected and the work is still going on." Where such cross-connections exist the board requires that all water used by the employees, whether for drinking or ablution, shall be supplied from the public system, through connections made on the street side of the double check valve. The law requires at least semi-annual inspections of valves on cross-connections.

Repairing Wood Water Conduit at Norfolk, Virginia

Ten Miles of 24-in. Machine-Banded Pumping Main Leaking So Badly as to Appear Hopeless Successfully Repaired

By J. W. Ledoux
Consulting Engineer, Philadelphia, Pa.

REPAIR of a 24-in. machine-banded, mortise-and-tenon joint wood pipe line delivering water under pressure for use in Norfolk, Va., became necessary in 1918 to cut down heavy leakage. The leakage was due somewhat to defective joint and alignment work during construction but principally to a flattening of the pipe by the earth load while the pipe was under low pressure, and an opening of longitudinal joints midway in the cross-section of the pipe when the conduit was subjected to heavy pressure. The repairs on the highest pressure portion were effected by putting special sleeves consisting of steel bands and rubber strips over the circumferential joints and by rebanding with steel rods and lugs. The local conditions, method of repair, and leakage tests before, during and after the repairs are detailed in this article.

In 1912 the Norfolk County Water Co., which had been supplying the suburbs of Norfolk, Va., from a system of driven-wells located six miles east of Norfolk, found its supply becoming insufficient for the growing demands, so secured water rights on streams draining some 45 square miles in Princess Anne County, 12 miles southeast of Norfolk, and began the construction of an impounding reservoir on the nearest one of the streams, known as North Landing River. The first development consisted of an earth dam impounding 441 m.g., the drainage area being 12.15 square miles and the water surface of the reservoir covering an area of 440 acres. A pumping station was built and two oil-engine belt-driven centrifugal pumps, each having a capacity of 3 m.g.d., were erected therein. The plan was to pump the water from the impounding reservoir ten miles to a 1-m.g. settling basin located at the driven well plant.

The experience of the water company with cast-iron pipe used for its pumping main from the well supply to its distributing system, as well as that of the city, whose supply was taken from impounding reservoirs on drainage areas similar to the North Landing reservoir, showed that in a very few years the carrying capacity of the pipe was reduced very materially, due to the combined effects of tuberculation and a hard clay-like internal coating; therefore a careful study was made to determine the best type of pipe for this ten miles of pumping main. An investigation indicated that a 16-in. cast-iron pipe would cost, laid, about the same as a 24-in. wood pipe of the cheapest type, and have only about a third the carrying capacity. The writer had previously installed 7,000 ft. of this class of wood pipe in Western Pennsylvania for a working pressure of 150 lb. per square inch and obtained fairly satisfactory results, so felt confident that the pipe could be made tight for the proposed pressure, which would never exceed 65 lb. per square inch at the pumping end of the line. So with some misgivings the water company decided to put in the 24-in. wood pipe under specifications that the lower half would be designed for a working pressure of 80 lb. and the upper half 43 lb. per square

inch; that it would be laid under the supervision of the wood pipe manufacturers and be satisfactory as to leakage. The construction was finished some time in 1913.

The pipe was made of 3-in. Norway pine staves, the walls having a nominal thickness of 2 in., machine banded with 1½-in. wrought iron, No. 14 B.W.G., spaced about ¼ in. apart, depending upon the pressure. The joints were mortise and tenon, made in the usual manner by simply driving the pipe in place by means of a "battering ram" handled by men.

The elevation of the pumps was about 10 ft. above tide; the elevation of the settling basin at the outlet end of the line 28 ft., so the pumping pressure when pumping at the rate of 3 m.g.d. was less than 20 lb. per square inch. A 10 x 50-ft. standpipe was located at the pumping station.

Under these conditions the plant was operated until the summer of 1918, when the cty of Norfolk, finding its own supply becoming inadequate due to the greatly increased demands of its enormously augmented population and the war activities of the Army and Navy Base, and knowing that it possessed a small drainage area and large storage capacity while the Norfolk County Water Co. possessed a comparatively large drainage area and small storage, entered into negotiations resulting in a contract to lease for three years the Norfolk County Water Co.'s plant, unify both systems and thus secure an additional supply of at least 4 m.g.d from North Landing reservoir. This contract provided for the installation of an electrical transmission line, duplicate pumps, motor-driven, having a combined capacity of 8 m.g.d., and it was reasoned that this amount of water could be pumped through the line as long as any water was available from the North Landing reservoir. It was further provided that the water would be discharged into the nearest city lake at a distance of about 40,700 ft. from the pumping station, and that the 24-in. wood pipe must carry 8 m.g.d. as determined by a service test made in a manner satisfactory to the city engineer.

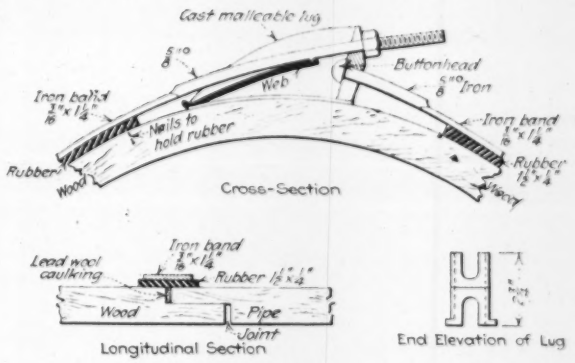
Leakage Under Pressure

At this time, July, 1918, the new pumps were supposed to have been contracted for by the Army Base which had charge of all the improvements and the unification of the two systems, and it was necessary to have the pumps before an adequate test could be made.

It was assumed that when 8 m.g.d. were pumped, the pumping pressure would increase to 53 lb. and in all probability develop a considerable amount of leakage which, if it did not take up, would require repairs by the water company.

To get an idea of the extent and distribution of any leaks that might exist under such pressure as was available, a test was made with the old pumps and standpipe by shutting successively each valve on the line, located about a mile apart, and the flow was measured by a Venturi type of meter. The results were astounding. In the first 24,000 ft. under a pressure of 21 lb. per square inch, the leakage amounted to 2.4 m.g.d. and an inspection of the line showed the leakage to be almost continuous for the entire distance. It was then decided to repair to the first valve, some 6,500 ft., which showed a leakage of 0.7 m.g.d. When the pipe was uncovered it was found that practically every joint leaked and nearly every pipe leaked along the staves, halfway between the top and bottom.

So it was decided to reinforce the entire length with rods between the circumferential joints and with bands over the joints. The rods were ¾ in. in diameter, secured by double malleable iron lugs. Several methods were tried before finding a satisfactory joint reinforcement. In the first method the outer part of the old joint, between the pipe-length ends, was caulked with lead wool. Then a ⅛ x 6-in. iron band, bolted at the ends so as to form a sleeve with a diameter 1 in. larger than that of the outside of the pipe, was centered over the joint and the space between the sleeve and the pipe filled with leadite poured through a pipe jointer. Although apparently successful at first, in a few days the leadite gave way through erosion. Neat cement was then used and found to be effective as regards tightness but was too costly because of the necessity for digging large bellholes to enable the cement pouring work to be done properly. After much further experimentation a circumferential joint was devised (see sketch) that was the most effective and economical of all those tried. The joint was scraped off all around the pipe, and, at the top, for a distance of 12 in., it was caulked with lead wool. A strip of rubber 75 in. long, 1½ in. wide



METHOD OF BANDING 24-IN. PIPE JOINT

and ¼ in. thick was stretched around the pipe, centered directly over the joint, and tacked on the pipe at each end of the strip, leaving a space 6 in. wide between the ends. Upon this was placed a wrought-iron hoop, ⅞ in. thick, and 1¼ in. wide, made taut by a bolt end and lug. This band was made out of ⅝-in. round iron by means of a steam hammer, leaving one end for a buttonhead and the other end for a thread 5 in. long. As the thread was screwed up the hoop was hammered and the leakage effectively stopped for any desired pressure.

Near the end of each day, before the trench was back-filled, a pressure test was applied to the line and any leaky joint that developed was made tight by screwing up on the bolt end of the hoop and hammering. The joints were about 8 ft. apart, and two men could repair about 25 joints a day after the digging was done.

For the first 6,500 ft. the pipe between the joint bands was continuously reinforced by the ⅝-in. rods already mentioned. The next mile required only occasional bands where stave leaks occurred, but practically every joint for a distance of 23,000 ft. had to be repaired.

The electric pumps were not obtained until April, 1919, or after two miles of pipe had been repaired, and then only one pump could be operated on account of the inadequacy of the electric transmission line. The capacity of one pump was about 5 m.g.d.

In April a test was made which showed the leakage

for the first 11,000 ft. to be 1.7 m.g.d. under 29 lb. pressure and 4.6 m.g.d. under 30 lb. pressure. Up to the first valve, a distance of 6,500 ft., the leakage was 0.43 m.g.d. under 42 lb. pressure and 1.1 under 64 lb. pressure. At this time the leakage on the entire 10 miles, while pumping at the rate of 4.67 m.g.d., was 0.47 m.g.d. While the pressure at the pumps was 30 lb. the average pressure on the second section was about 26 lb. This leakage was determined by deducting from the rate of pumpage the discharge over a weir at the outlet of the pipe, 50,000 ft. from the pumps.

By July, 1919, the first three sections, or about 17,400 ft., had been repaired and both pumps were in operation, so that for the first time it was possible to pump into the line nearly the full contract quantity of water at the required pressures. A test showed the following results:

	Pump Pressure Lb.	Total Leakage Gal.
Up to the first valve closed	65	510,000
Up to the second valve closed	55	1,260,000
Up to the third valve closed	45	3,000,000
Up to the fourth valve closed	35	1,950,000

After the test an application of sawdust was made and then a second test showed the leakage to be:

	Pump Pressure Lb.	Total Leakage Gal.
To the first valve	65	100,000
To the second valve	55	970,000
To the third valve	45	1,690,000
To the fourth valve	35	1,500,000

Work was then continued and frequent tests made to locate and repair the portions of the line showing leakage, until Dec. 20, when a test was made subjecting each section successively to the pressure necessary to pump 8 m.g.d. to the nearest city lake, as per contract. The results were as follows:

	Pressure Lb.	Leakage Gal.
First section	57	40,000
Second section	48	35,000
Third section	40	46,000
Fourth section	30	58,000
Fifth section	21	59,000
Sixth and seventh sections	13	35,000
Total leakage, gal.		273,000
Total distance, ft.		40,700

The leakage was measured by means of a 2-in. Empire meter placed on a by-pass around a gate valve located close to the pumping station. One of the pumps was operated at full capacity, allowing sufficient water to go through the line to maintain the required pressure, the balance of the water being discharged back into the suction well. The plan was first to pump with the 7th valve closed and the entire line subjected to 13 lb. pressure for an hour, measuring the flow through the 2-in. meter; then the 7th valve was opened and the 5th valve closed and the entire line up to the 5th valve subjected to 21½ lb. pressure for half an hour and to 13 lb. pressure for half an hour, deducting this last flow from the first to determine the leakage from the 5th to the 7th valve. In this manner pressure and leakage determinations for the whole length were made for two pressures in each case.

Up to this time and latterly the formula of flow was found to be $Q = 4{,}640{,}000\sqrt{h}$, in which Q = gallons per 24 hours, and h the loss due to friction in feet per 1,000, the coefficient corresponding to about 103 in Chezy's formula, although in the early tests it was found to be only 97.

The water company then asked for an official test and acceptance of the line, so on Feb. 21, 1920, the first official test was made, the following engineers being represented: Walter H. Taylor, 3rd, formerly city engineer and then director of public works of Norfolk; Dabney H. Maury, consulting engineer; N. Z. Ball, representing the city; J. W. Ledoux, consulting engineer, and C. C. Behney, representing the water company.

The first operation was to calibrate the Simplex meter at the pumping station. Then a pitot tube traverse and velocity test was made at a tap close to the pumping station. Then a traverse and velocity test was made at a tap on the 24-in. pipe at a point on the line 40,300 ft. from the pumping station. At that point the pipe was found to be elliptical in form, the internal major or horizontal diameter being 25½ in. and the minor or vertical diameter 22¼ in. The following were the main results:

Length of line pumped through	49,900 ft.
Length of line to nearest city lake	40,700 ft.
Length of line to Pitot tube	43,300 ft.
Pressure at pumping station during test	55.7 lb.
Passage as measured by Simplex meter	7,680,000 gal.
Pumping as measured by Pitot tube near pumping station	7,680,000 gal.
Flow at tap 40,300 ft. from pumping station	7,470,000 gal.
Apparent leakage	210,000 gal.
Equivalent delivery through line into nearest city lake—distance 40,700 ft.	9,175,000 gal.
Deduced formula of pipe flow	$Q = 5{,}070{,}000\sqrt{h}$

Necessary pressure at pumping station to deliver 8,000,000 gal. into nearest city lake, 49 lb.

Comments and Conclusions

During all this work there was abundant opportunity to inspect the condition of the pipe and the iron banding, and no evidence of deterioration could be seen, so that as far as the iron and wood are concerned, the future life of the pipe is indefinite. This is probably due to the favorable character of the soil in which the pipe is laid.

While original defective alignment and joint work were no doubt responsible for a great deal of the leakage the most important lesson taught is that wood pipe should be continuously subjected to the pressure under which it is to operate. This particular pipe for the first five years after it was laid was subjected to a maximum pressure at the pumping station of about 18 lb. per square inch and at the upper portion of the line to about 5 lb. The earth filling over the pipe, averaging about 2 ft. in depth, exerted a sufficient pressure to gradually press the pipe into an elliptical form, which it retained until when the high pressure was applied the effect was to force the pipe back into a cylindrical form, which could be seen by a crack in the earth all along the center of the pipe line, or at least for the first 20,000 ft. By continuing this pressure the earth filling assumed its new permanent position, which it would retain unless the pipe were permitted to work under a low pressure again for a considerable length of time, say several weeks, depending upon whether the soil were fairly dry or saturated.

This condition of flattening of the pipe was probably responsible for most of the trouble above outlined. On the upper portion of the line the difference in internal pressure was never great enough to cause the pipe to resume its circular form after it had once been pressed down into the elliptical shape.

If the pumping machinery had been installed promptly, as was originally anticipated, the cost of repairs would in all probability have been reduced by 50 per cent and if the pipe had been originally laid under a very light fill it would not have been pressed out of shape, for wood being an organic substance will gradually take a permanent set even when subjected to external pressure far below the elastic limit.

The experience herein related does not discredit wood pipe; neither does it condemn the original form of joint, although I much prefer the form used in the repair on account of its adjustability.

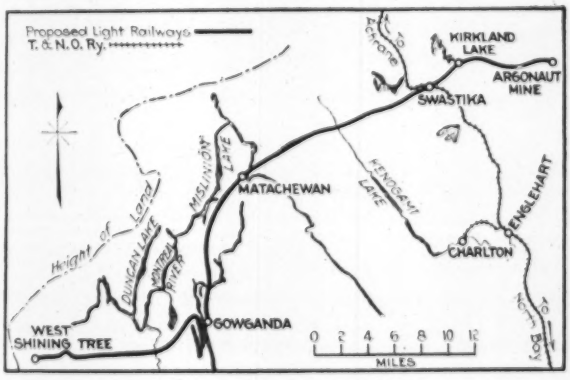
The reason why the coefficient of flow has increased so favorably, or by about 16 per cent, is partly that the increased peripheral velocity has cut away the adhering scum and partly that the hydraulic mean radius of the pipe has increased due to the final change from elliptical to circular form.

Taking the results of the tests of pressure to which the various portions of the line have recently been subjected without increasing the leakage, and using the formula of flow which is now applicable, it is certain that the pipe line now has a safe capacity of 9.6 m.g.d. when delivering into the nearest city lake, which is 20 per cent above the contract requirements.

Light Railways for Canada

TEMPORARY pioneer railways of 3-ft. gage are planned for Temiskaming County in northern Ontario, to develop agricultural and mineral resources and to serve mines now handicapped by lack of railway accommodation. Isolated mining properties are said to pay $20 to $30 per ton for hauling in machinery and supplies by teams over rough trails. It is proposed that when traffic has reached a certain limit these lines would be converted to standard-gage branches at little additional cost, the original track and equipment being then used for development at some other location.

Two lines are now projected, starting from Swastika on the Temiskaming & Northern Ontario Ry., about 400 miles north of Toronto. As shown by the accompanying



PIONEER RAILWAYS FOR ONTARIO

map, one is to run west and southwest to Gowganda and West Shining Tree, about 80 miles; the other is to run east about 20 miles to the Argonaut gold mine. A portion of the longer line was surveyed in 1913 by the T. & N. O. Ry., but this project was abandoned on account of the war. The country is rugged and broken but not very hilly, with an elevation of about 1,000 ft. above sea level and keeping within the limits of the divide known as the height of land (elevation 1,200 ft.). It is heavily timbered in some parts and the open portions include both farming and barren lands. There are innumerable streams and lakes, with possibilities of water-power development.

It is stated that the two railways would serve an area of some 3,000 square miles, in which are located a number of gold and silver producing mines and about 11,000 mining claims for gold, silver, barium, asbestos, feldspar, copper and iron. The timber resources include both lumber and pulp wood. Few roads or trails traverse the district.

Grades of 3 per cent and 12-deg. curves would be the limit in location. Track construction is to consist of 56-lb. rails on jack pine ties 5 x 6 in. and 6½ ft. long, laid with sixteen ties to a 30-ft. rail and ballasted lightly with gravel. Passing sidings 200 ft. long are to be provided at five-mile intervals and there will be about ten small frame stations. Grading will average 12,000 cu.yd. per mile, only about 4 per cent of which is rock, as the location is governed largely by the requirement for low first cost. A considerable amount of trestling will be required.

Steam locomotives of about 15 tons weight and using oil fuel are proposed, the equipment for 100 miles of line including six locomotives, twelve passenger cars and 100 freight cars. Freight-car loads will be limited at first to 10 tons, though it is expected they may be increased to 20 tons when the roadbed has become compacted. The cost is estimated at $15,500 per mile, of which $2,500 represents engine and car equipment. Construction work will be done probably by general contract or by station-men, except that the company will do the tracklaying and ballasting.

This project of the Northern Light Railway Co., of Toronto, awaits approval by the railway department of the provincial government of Ontario, but it is hoped that work can be commenced in the autumn. Col. R. P. Rogers is manager and chief engineer.

Wood Stave Pipe Stands Blast and Fire

TWO tests of machine-bound wood stave pipe, one accidental and one planned, took place recently at Seattle, Wash. In one the pipe was bent by a blast. The other was a fire-resistance test.

In the first case to be noted a dynamite blast unexpectedly sprung two 16-ft. lengths of 6-in. water main under 115 lb. pressure into a reverse curve, with a maximum ordinate of 8 in. The resulting leaks were stopped with wedges and the line continued in service for six days. Since then the line has been relocated. The main had been in use 13 years.

Shortly before this incident a fire-resistance test of 6-in. creosoted wood stave pipe, under 125 lb. pressure, was made by the Continental Pipe Manufacturing Co. in its Seattle yard. The staves of this pipe had been creosoted with 8 lb. pressure and vacuum treatment. The pipe was spirally wound with No. 6 galvanized-steel wire, 1 in. c. to c. The 8-ft. pipe lengths tested were plugged at each end with wood connected by a steel rod extending through the pipe. A corporation cock was used as an air vent. After the pipe had been under city pressure for 16 hours the fire test was begun. The following account of the test has been supplied by the company named above:

The test section was completely covered with fine kindling saturated with kerosene oil. The fire was then kindled and immediately became intensely hot, causing the galvanized steel wire winding to elongate. This elongation permitted the staves to separate. The consequent leakage immediately reduced the intensity of the fire and eventually extinguished it. The pipe section continued to leak considerably through the seams. The leakage, however, diminished as the wire winding cooled. Two hours after the fire had been started most of the leakage had stopped; and two hours later leakage had entirely ceased.

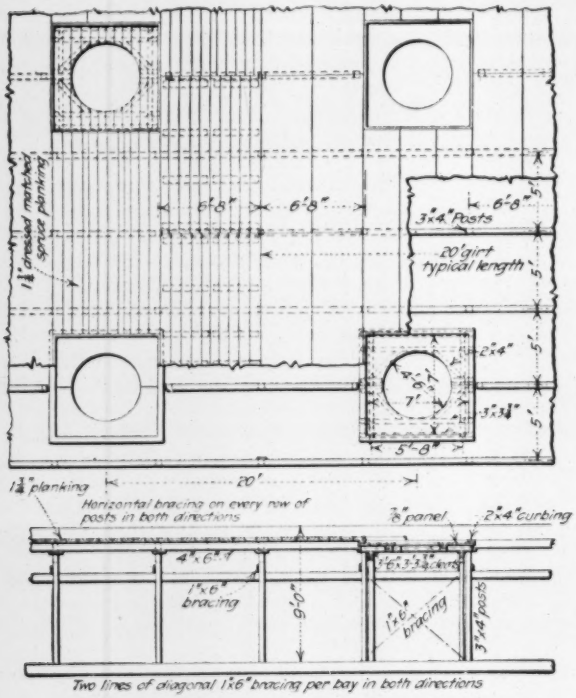
Using 1¾-in. Plank for Flat Slab Floor Forms

By J. E. Gurvin
Superintendent, Aberthaw Construction Co., Boston, Mass.

CAREFUL records of erection costs have indicated that a considerable saving may be effected in forming flat slabs by the use of panels of 1¾-in. matched plank instead of the ⅞-in. panels ordinarily used. The scheme has recently been tried out by the Aberthaw Construction Co. in the construction of a storehouse for the Monadnock Paper Co. at Bennington, N. H.

The features of the system are the elimination of the joists and the batting of panels on the girts. Plinths or drop panels are supported by form posts, suitably braced. Sizes of panels were limited so that none were too heavy for convenient handling.

It can be seen that successful erection is made possible only by accurate spacing and alignment of posts and girts. Spacing was maintained by cutting ledgers for horizontal bracing to such lengths that each ledger covered three posts extending out to out, and having marked on it the location of the intermediate post. All braces of the same length were given distinguishing marks to prevent misplacement. The bottoms of the posts in alternate rows were lined and spaced by a straight line of ledgers nailed to the green



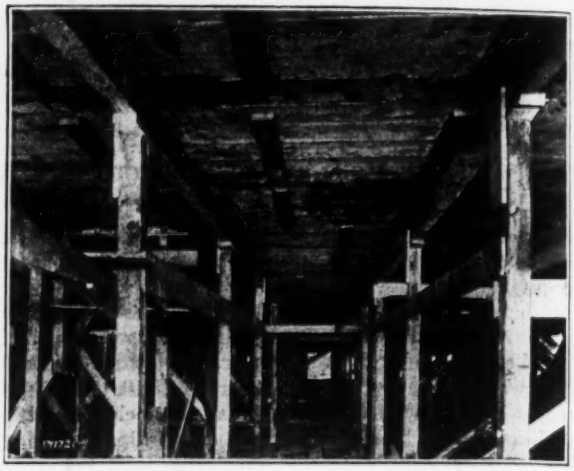
DETAILS OF SPECIAL FLAT-SLAB FORMS

concrete floor at the edge of the row and having marked on it the location of each post. Alternate posts in the rows so marked, or in other words only the posts coming at the ends of the horizontal braces, were first erected; then the intermediate posts were filled in at the marks on the braces. During the above described operations, plinths were being erected and by the time girts were nailed in place, laying of the panels could proceed.

Approximately 15 per cent more material is required than with the ⅞-in. panels, but this is offset by increased salvage value of the 1¾-in. stock. Panels were stripped with practically no breakage, and at the end of the job it was decided that their condition would warrant their being used on another job of the same type. Each panel was used from three to five times.

Records were kept on labor costs of the four principal items, namely, posts, plinths, girts and panels. These records indicate that the cost of the under structure and plinths of the new type will be slightly less than the cost of under structure of the old type if joists are included with the latter.

On the operation of laying the panels, however, a



HEAVY PLANK ARE BASE OF FLAT-SLAB FORMS

saving of nearly 50 per cent over the old system was realized. It must not be supposed, however, that this was entirely due to the new type of panels. Weather conditions were favorable and a plentiful labor supply rendered a picked organization possible. The story height was low and the layout an ideal one for getting good costs.

A few other advantages were noted. Patching of panels due to breakage was practically eliminated and ceilings were somewhat more smooth and even. It has been noted that with the old style of centering where plinths are supported by special joints, loading suddenly applied during the pouring of the concrete would sometimes cause pronounced settlement of the plinths through flexture of the supporting joists. By the method of supporting plinths with the new type, this condition cannot obtain.

Finally, if we deduct from the actual saving a liberal allowance for the favorable conditions existing on this job, it is surely being conservative to say that with the new type of centering, a saving of from 20 per cent to 25 per cent should be effected.

Gravel Test Road for Heavy Traffic

A 30-ft. gravel road 2½ miles long is to be constructed by the Wisconsin Highway Commission in conjunction with the Dane County highway officials to determine the sufficiency of well maintained gravel surfacing under heavy traffic. The test road is located just outside of Madison, Wis., and is a section of main trunk highway having a very heavy traffic. In its quarterly report the State Highway Department says: "If a success, gravel will be used in the future in many places where we now consider concrete paving necessary."

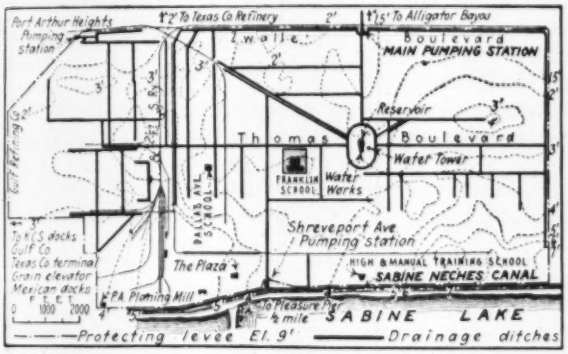
The Cost of Anti-Malaria Work in Port Arthur, Texas

By R. G. Upton
City Sanitary Engineer

THE Engineering Department of the city of Port Arthur, Texas, has promoted anti-malaria and mosquito eradication work for several years past by drainage, street improvement, and other efforts, spending large sums of money annually. These improvements are of great value to the city other than as mosquito prevention measures, but they will be considered here from the viewpoint of anti-malaria work only.

The entire city is now well drained and the streets improved. The main drainage ditches are below mean gulf level, so that all water and about 90 per cent of the sewage is pumped up to gulf level, which makes both equipment and maintenance an ever present cost. The city is also inclosed by a storm levee to protect it from storm water from surrounding country. The city now covers 3,500 acres and has about 65 in. of rainfall annually, but has practically no runoff.

To understand the anti-malaria work that has been done here, one must contrast past conditions with the



PORT ARTHUR DRAINAGE AREA

present as well as compare the present with the ideal. The present townsite was formerly little better than a marsh with a slight slope from Lake Sabine back toward Alligator Bayou. Houses were built first near Sabine Lake on the higher points of land. The area now comprising the city was frequently overflowed by salt water from storms and by fresh water from rains. Both fresh and salt water mosquitoes were then a serious impediment to the progress of the city. Since that time the mosquito menace has been decreasing.

The history of drainage work done here goes back to 1897 when the Port Arthur Townsite Co. installed a pump at the end of 19th St. to throw the water over the railroad grade. No data on the cost of the equipment or operation are available. The next improvement was the drainage canal on Shreveport Ave., which was provided with flood gates to keep out back water and with pumps to lift the water to gulf level. This work was completed in 1903 and the successful operation made habitation possible as far back as Seventh and Eighth Streets in the downtown district. Rapid growth of the city led to ditching and to the addition of pumps, which system was completed in 1913 but was found inadequate after the storm of 1915. This storm flooded the entire city with from 2 to 5 ft. of salt water. The present system was begun after this storm.

The present drainage system consists of three pumping stations at the ends of the main ditches, to lift the water to gulf levels; four miles of storm sewers, 23 miles of main drainage ditches, 105.2 miles of gutters and laterals on improved streets, and a protecting levee ten miles long surrounding the city. This levee has an elevation of 9 ft. above mean gulf level, which is 2 ft. higher than the highest known storm-water invasion from the gulf. First cost and annual upkeep are not small items of expense but the value received in protection to the city is great. For anti-mosquito work it is indispensable because it keeps out all storm water and enables the drainage system to operate so that the entire city is comparatively free from standing water a few hours after the heaviest rains, where formerly were only swamps and marshes. People who are not familiar with the local conditions should bear in mind that rain in this section of the country comes in floods, sometimes as much as 6 in. in 24 hours. The ditches, pumping stations, and levee were installed by a bond issue of $180,000.

Other items chargeable to anti-malaria work come under street improvements. Where formerly we had ruts and water holes in the streets we now have asphalt and shell. We are charging one-third of the asphalt street improvements and one-half of the shell street improvements to drainage or anti-malaria work. This division of cost is not entirely arbitrary for we have calculated that grading, leveling, and ditching cost about that portion of the total amounts. Below is given a summary of improvement costs that are properly anti-malaria work, since 1915. Cost prior to this is unavailable.

COST OF INSTALLATION CHARGEABLE TO ANTI-MALARIA WORK SINCE 1915

Drainage bond of 1916	$180,000
Asphalt street bonds, $164,000 (one-third charged)	54,666
Shell street bonds, $292,000 (one-half charged)	146,000
Total	$380,666

The cost of maintenance for one year is given below. The street and bridge fund is chargeable largely to anti-malaria work, which consists in repair on ditches and culverts, extensions, filling of holes, cutting of grass and cleaning and sprinkling. We have estimated that at least three-fourths of this fund goes to anti-mosquito work.

MAINTENANCE COST FOR ONE YEAR

Pumps and ditches (budget)	$12,000
Streets and bridges (Budget, $40,000; three-fourths charged to anti-malaria work)	30,000
Storm levee repairs	500
Total maintenance	$42,500

Other anti-malaria work not included in the above is carried on by private citizens, such as screening of cisterns and filling in lots. Filling costs from $25 to $200 per lot for a large part of the city. In addition to the work of the Engineering Department there are Health Department ordinances which require cutting of grass and screening of cisterns, and which forbid standing water on any premises.

The Engineering Department has had the support of the entire citizenship in the anti-malaria work in the past, and future progress is to be expected. Due credit should be given to drainage and improvement work done by Jefferson County and also to the Gulf Refining Co. and the Texas Co. for improvements made by them adjoining the city of Port Arthur.

Government Engineers Report on St. Lawrence Waterway

Engineering Features of Navigation and Power Development of River from Lake Ontario to Montreal, as Reported to International Joint Commission by Col. W. P. Wooten and W. A. Bowden

With Insert Sheet of Drawings

BY HARRISON G. ROBY
Principal Assistant to the American Government Engineer, Detroit, Mich.

In the fall of 1919 the Canadian government accepted the invitation of the United States government to undertake a joint investigation of the improvement of the St. Lawrence River for deep-draft vessels, in the interest of both countries, and for the most beneficial use of the waters. To the International Joint Commission were referred the questions as to the economic advantages to be derived from the improvement, as to the traffic that is likely to be carried upon the proposed route, as to the apportionment of capital cost, and of cost of operation and maintenance of the improvements, and as to the best method of improvement, including the draft of water and the development of power. The report of the commission will be submitted to the two countries this fall.

To facilitate the work of the commission each government appointed an engineer for the purpose of acquiring data and of preparing complete outline plans for and estimate of cost of the improvement. W. A. Bowden, Chief Engineer, Department of Railways and Canals, was named by the Dominion of Canada, and Col. W. P. Wooten, Corps of Engineers, U. S. Army, was designated by the United States government. The joint report of the engineers was submitted to the commission on July 1 of this year. The present abstract of the report gives its salient features.

THE total length of the St. Lawrence between Montreal and Lake Ontario is about 182 miles, and the difference in elevation is 224 ft. The work of improving the river is made feasible because of three important advantageous conditions. The first of these is that the obstructions to navigation are concentrated in comparatively short stretches, with longer stretches between the drops which require little or no improvement. The second condition favorable to the construction of the proposed works is the location of rock ledge within reasonable depths at all sites of necessary structures, and at the same time below the bottom grades of the proposed canals for a large part of their total length. The third advantage is the large amount of water-power made available by the proposed works, due to the large and remarkably even flow of the river. The sale of this by-product will go a long way toward carrying the entire cost of the improvement.

For the purpose of discussing the treatment to be accorded the St. Lawrence it is divided into five divisions, as follows: (1) Montreal Harbor to deep water in Lake St. Louis; (2) Deep water in Lake St. Louis to end of breakwater at Lake St. Francis terminus of proposed ship canal between Lake St. Louis and St. Francis; (3) End of breakwater to lower end of St. Regis Island; (4) Lower end St. Regis Island to Chimney Point; (5) Chimney Point to Lake Ontario. Of these divisions the first three lie wholly within Canadian territory. The international boundary line follows the river throughout the fourth and fifth divisions.

The decisions reached as to the improvement to be made in each division to obtain the necessary depth of navigation and to obtain the greatest beneficial use of these waters are summarized in the following conclusions:

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The physical conditions are favorable for improvements for navigation which will be permanent, and will have very low upkeep costs. For the project as recommended in the report, the total cost of improvement from Montreal to Lake Ontario is $252,728,000. This is an estimate based on present day prices, (which are about 80 per cent above pre-war prices) for a 25-ft. depth with such provisions that a 30-ft. depth may be secured later without interfering with the use of the waterway. It also includes the cost, to the switchboard, of developing 1,464,000 hp. The total annual cost of operation, maintenance and depreciation of these works is $2,562,000. Of this sum $1,457,000 is properly chargeable to the operation, maintenance and depreciation of power plants. The estimated cost of increasing the navigable depth throughout the entire stretch to 30 ft. at a later date is $17,986,180. (See detailed figures on opposite page.)

The more intangible assets to be derived from this improvement, such as the development of industries in both countries, the advantages of deep-water navigation from the ocean to the Great Lakes, the saving of coal, and the improvement in railroad freight conditions, while of great importance to the two countries, are not considered in this report, as the engineers do not understand that their instructions cover an investigation of these matters.

POWER POSSIBILITIES

Improvement of the entire reach from Montrea. to Lake Ontario for navigation alone is feasible, but the loss of power that can be generated as a byproduct in some reaches is not warranted. The development of nearly all the potential power in the river amounting to approximately 4,100,000 hp. can be made as co-ordinate parts of schemes for the improvement of navigation.

The simultaneous development of such a vast quantity of power is not a sound economic procedure, as a market to take this output is not now in existence, and cannot be expected to spring into being at once. The sound method of procedure is to improve for navigation alone those reaches where side canals and locks can most economically be used, and where the development of the power at some future time is not interfered with by the proposed improvement and, in that part of the river where the construction of locks and dams offers the

most feasible means of improving navigation, to provide for the development of the incidental power obtainable as a result of the heads created by the dams.

If the improvements are carried on simultaneously it will be possible to complete them in eight years from the time the work is begun, if funds are made available as fast as needed.

The details of the power and navigation project are summarized in the accompanying table and the location and profiles shown on the drawings on the accompanying insert sheet.

All locks are given the same inside measurements as those now being built at Welland, which are 860 ft. c. to c. of quoins of gates, and 80 ft. between lock walls. The bottom width adopted for canal prisms is 220 ft. for 25-ft. depth and 200 ft. for 30-ft. depth. One bank is placed far enough away from the center line to allow the widening of the canal to 400 ft. in the future, if desirable. Channels in the lakes are given a width of 450 ft. In river sections, where a reduction in velocity is also necessary, the project channel width is greater, varying from 600 to 1,000 ft. A description of the development, by divisions, follows:

TABLE SHOWING DETAILS AND COSTS OF PROPOSED ST. LAWRENCE WATERWAY

Division	Length — Canal	Length — River	Total Mi.	Change in Elev. Ft.	No. of Locks	Hp. Dev.	Estimated Cost, 25 Ft.	Estimated Maintenance	Estimated 30 Ft. Depth	Possible Hp.
1. Montreal-Lake St. Louis	13.0	12.0	25	45	2 (1 guard)	.....	$55,783,000	$350,000	$12,944,000	860,000
2. Lake St. Louis-Lake St. Francis	13.5	2.5	16	83	2 (1 guard)	.....	36,590,000	400,000	3,110,000	1,560,000
3. Lake St. Francis-St. Regis Island	0	28.0	28	3	0	.....	1,158,000	30,000	662,000	.....
4. St. Regis Island-Chimney Point	7.5	40.5	48	92	3	1,464,000	159,097,200	1,762,000	1,270,180	180,000
5. Chimney Point to Lake Ontario	0	65.0	65	1	0	.....	100,000	20,000	.....	.....
Total	34.0	148.0	182	224	7 2 (guard)	1,464,000	$252,728,200	$2,562,000	$17,986,180	2,600,000

First Division

This stretch comprises the rapids just above Montreal Harbor, La Prairie Basin, the Lachine Rapids, and the shoal at the lower end of Lake St. Louis. It is not navigated except by special passenger boats, ordinary traffic following the Lachine Canal. The difference in level between Lake St. Louis and Montreal at mean stage is 45 ft.

Several methods of improving this division have been investigated. The one that is recommended for adoption consists of a side canal on the Ville Emard route, with two main locks and a guard lock, as shown in the drawings. It provides for 25-ft. depth of navigation at the outset. The canal sections would have a bottom width of varying from 220 ft. in through cuts to 450 ft. in submarine channels. The locks are built for the ultimate depth of 30 ft. over sills, so that there will be no interference with navigation while the work necessary to secure the additional depth is being prosecuted.

Provision for the future widening of this waterway is made from Victoria Bridge to west of the town of Verdun. The cost of this improvement is estimated to be $55,783,000. The annual cost of operation, maintenance, and depreciation will be $350,000. Whenever 30-ft. depth for navigation is warranted, the additional work required in the First Division to obtain this will be the construction of a concrete dam, with control gates across the river at the Lachine Rapids, and the raising of the side walls of the canal sections at an estimated cost of $12,944,000.

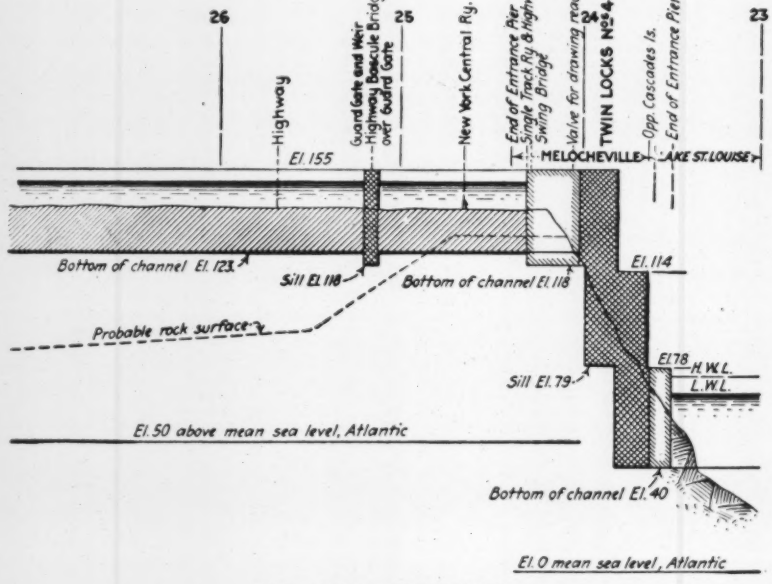
The ice conditions in this division of the river make the development of power more uncertain and more expensive than at other sites higher up, and the head that would be available is dependent to a considerable extent on the amelioration of ice conditions by power development in Division 2, which development should be made before that in Division 1, is begun. When the development of this power is required it can be made by the expenditure of $83,797,000, in addition to that required to complete the improvement for 30-ft. navigation.

The lowest lock (No. 1) is located about 2,000 ft. downstream from Victoria Bridge on the north side of the river. The lift at this lock at mean flow will be from El. 21 to El. 47. After passing the north approach to the bridge the canal will continue for a distance of 4,000 ft. above the foot of Nun's Island as an elevated pond created by a retaining wall on the river side and the Verdun level on the land side. Near the Verdun shore the pond is contracted by carrying a retaining wall from the level to within 300 ft. of the opposite wall. Culverts under the canal will provide for the discharge of the river St. Pierre and for the drainage of the town of Verdun.

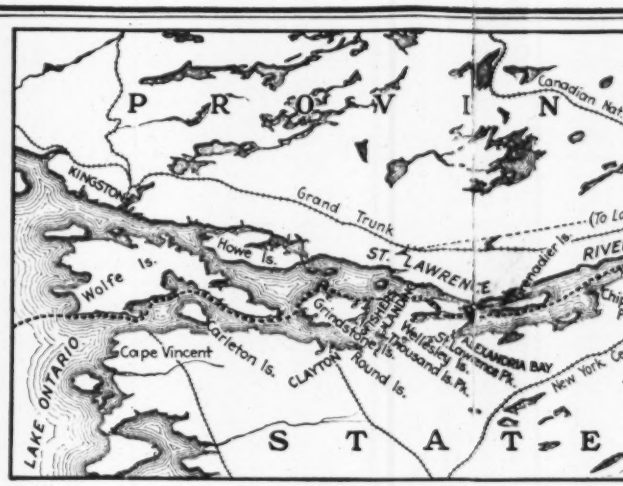
The second lock is located west of the town of Verdun. The lift will be from El. 47 to El. 65, which is a little less than the elevation of Lake St. Louis at low stage. After passing the lock, the route swings through an angle to the left, and proceeds parallel to and south of the present Lachine Canal, to the guard lock, which is located directly above the Canadian Pacific Ry. line which crosses the river. This lock is designed to take the difference in level between the reach below it, El. 65, and Lake St. Louis, which varies from about 65.5 to 74.0. After passing the guard lock, the canal passes south of the guard lock of the present Lachine Canal, enters the pool created by the breakwater of the Lachine Canal, and remains behind the breakwater to its end. In Lake St. Louis a large amount of solid rock dredging is required to obtain the proposed section at low water.

Another route which has been thoroughly investigated makes the cross-over from the river bank to the present Lachine Canal at some distance to the east of the recommended location. It leaves the river before reaching the foot of Nun's Island, and meets the Lachine Canal near the present Cote St. Paul Lock. This route is somewhat more expensive than the one outlined above both for 25-ft. depth and for 30-ft. depth. It also severs some parts of lower Montreal from the main body of the city, and in all respects is less feasible.

To make the river navigable by means of a dam near Victoria Bridge high enough to submerge the Lachine Rapids, or by means of two dams, one near Victoria Bridge and one at Heron Island, and a canal running along the north shore of the river from the head of the Lachine Rapids to Montreal Harbor, having two locks, one at Montreal Harbor and one about 4,000 ft. below the dam across the river, would provide a practicable method of improvement of this division. The power that is made available by the dam, however, is intermittent, because of the reduction in head in the winter caused by the rise in tailwater level due to the severe



TYPICAL SECTION
AT LOCKS 4 & 5



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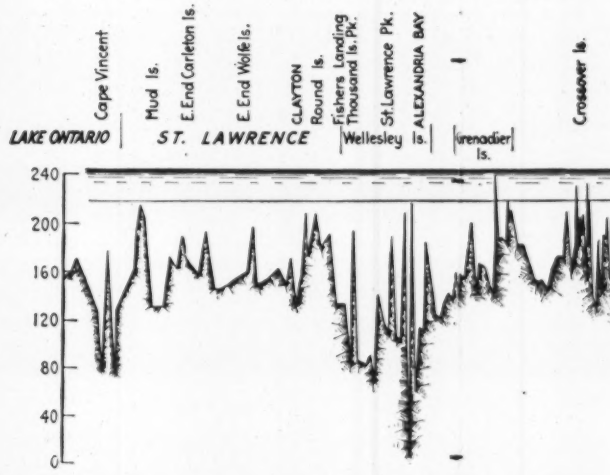
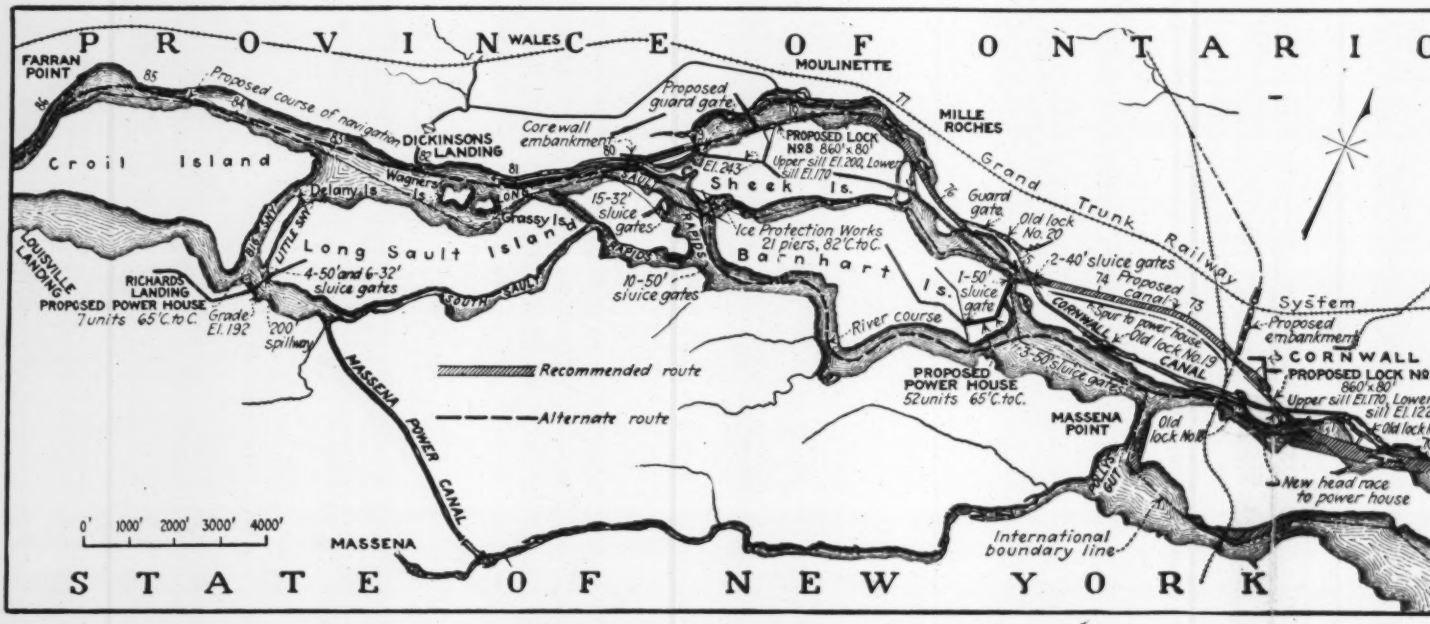
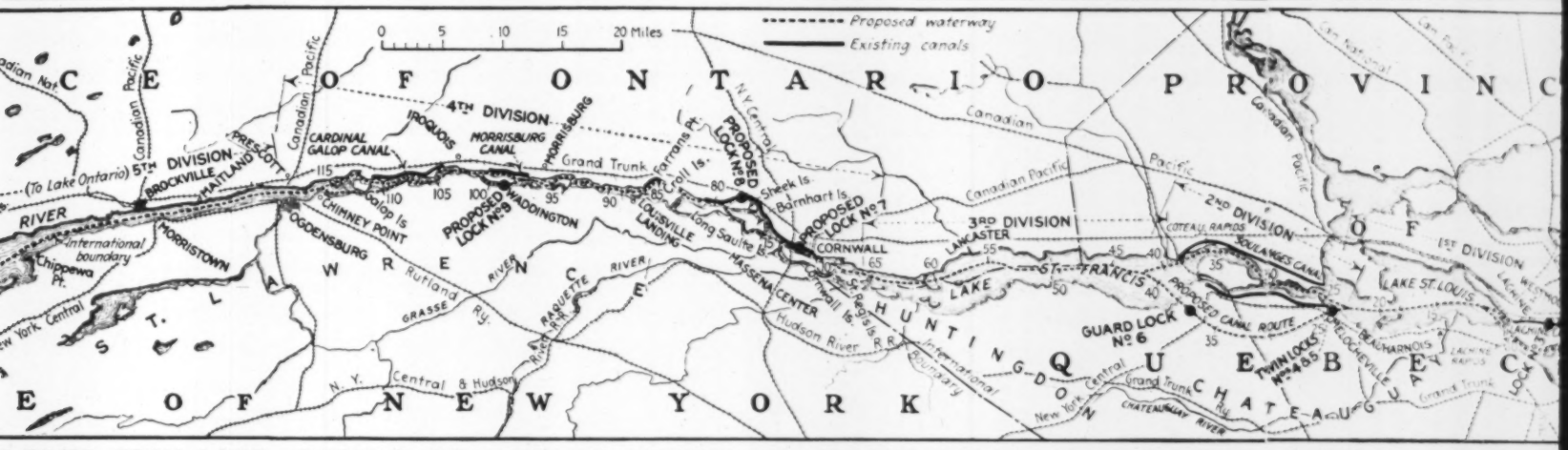




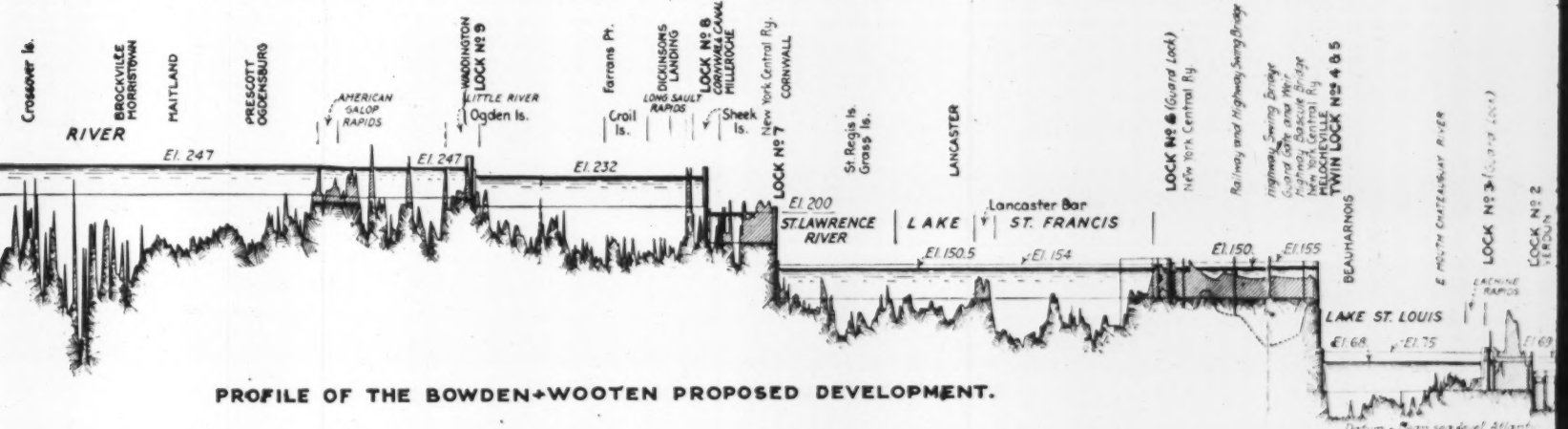
ENLARGED MAP OF FOURTH DIVISION

Maps, Profile and C

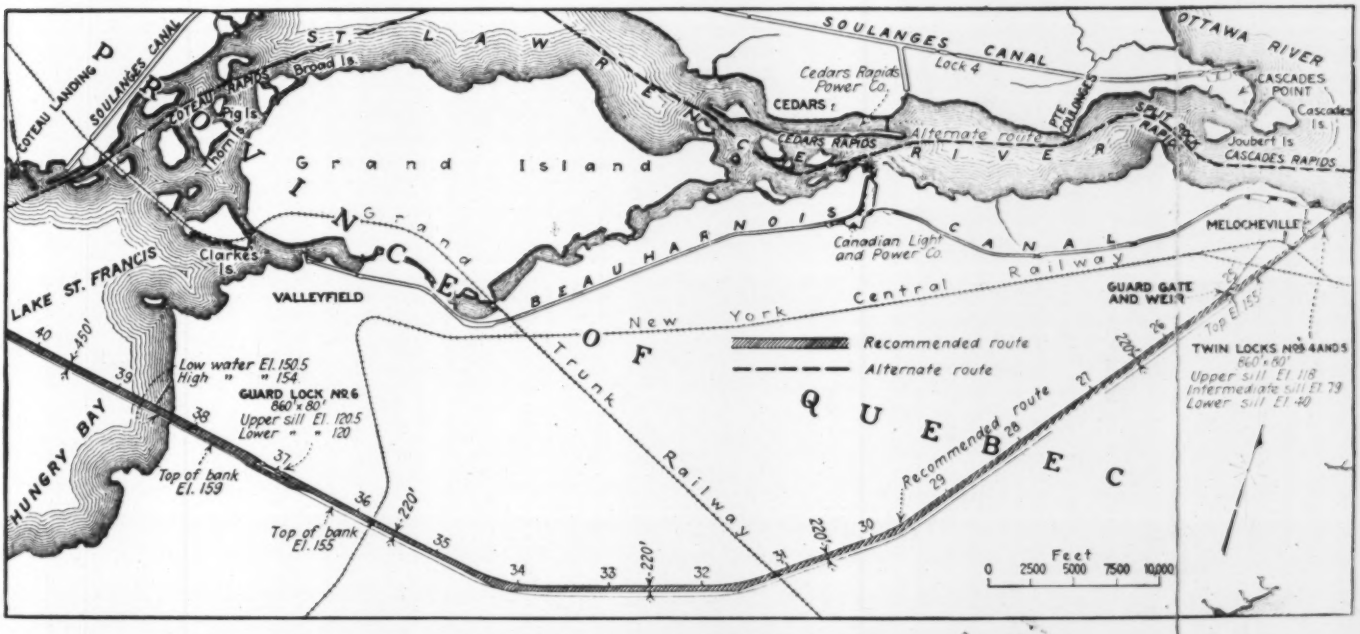
As Recommended in Report to International Joint Commission by Col.



E RIVER FROM LAKE ONTARIO TO MONTREAL SHOWING THE NAVIGATION AND POWER DEVELOPMENTS.



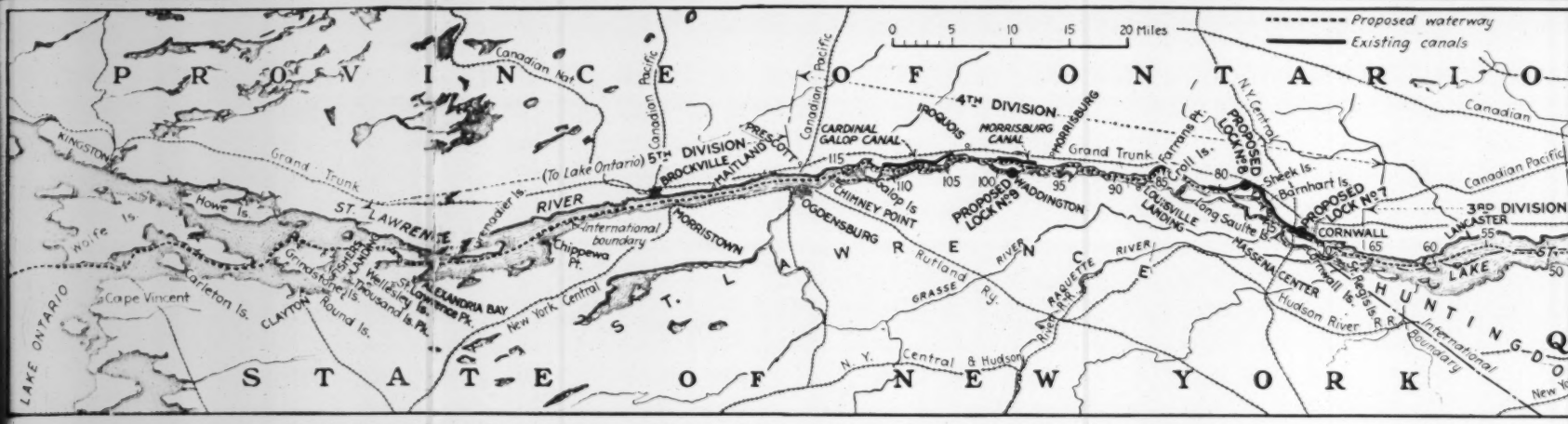
PROFILE OF THE BOWDEN-WOOTEN PROPOSED DEVELOPMENT.



ENLARGED MAP OF SECOND DIVISION

d Cross Sections of Waterway and Power Development of St. Lawrence River

Col. W. P. Wooten, Corps of Engineers, U. S. A., representing the United States, and W. A. Bowden, Chief Engineer of Department of Railways and Ca



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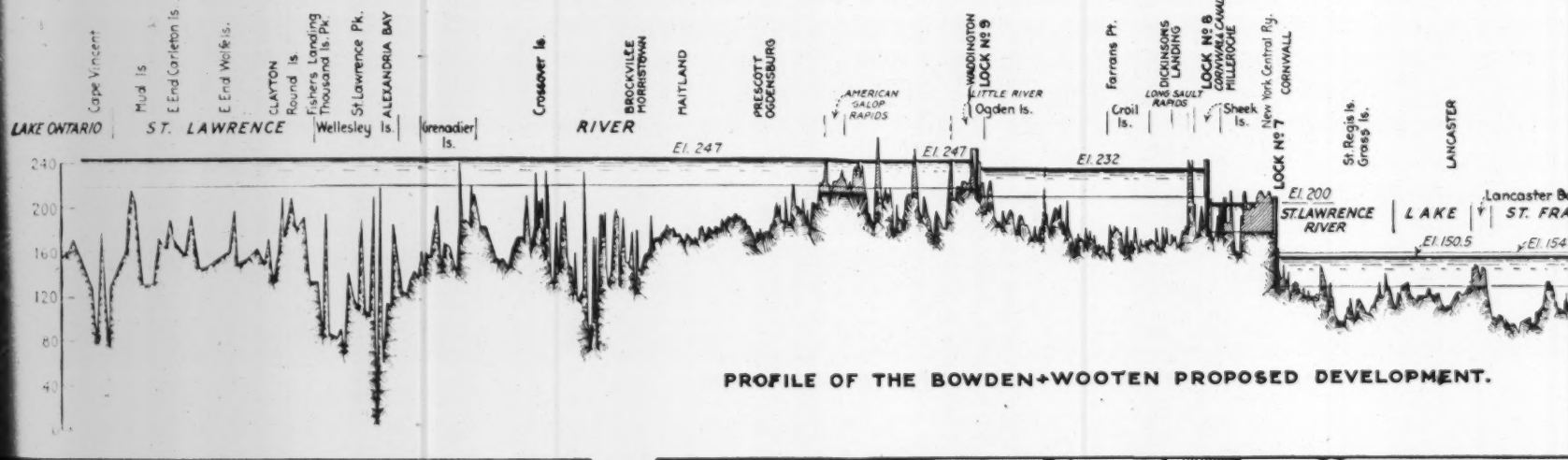
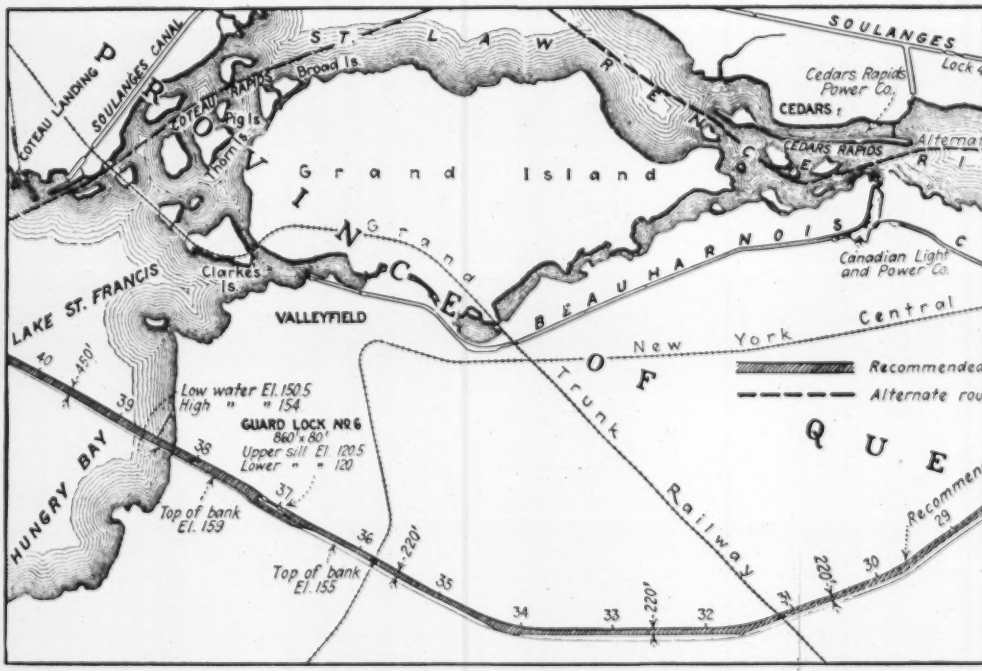


PROFILE OF THE BOWDEN+WOOTEN PROPOSED DEVELOPMENT.

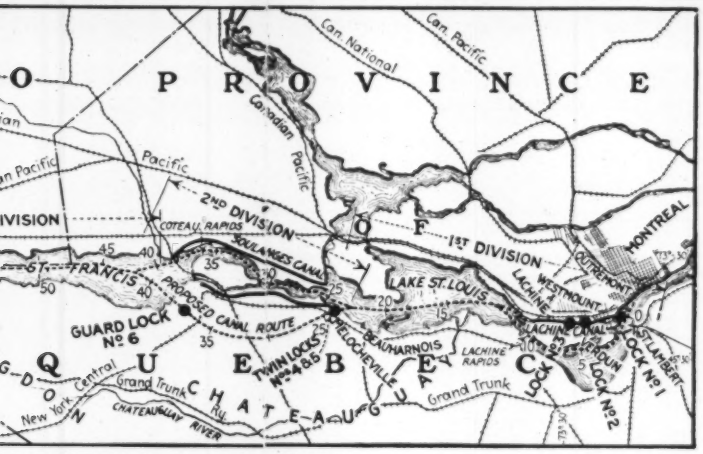


H DIVISION

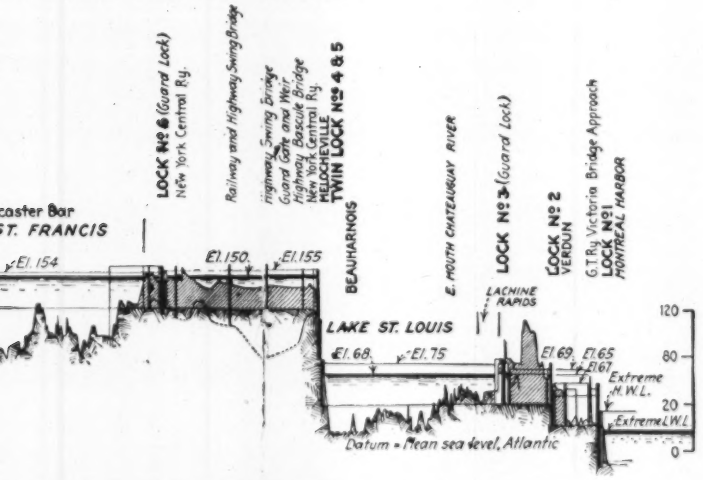
ENLARGED MAP OF SECOND DIVISION

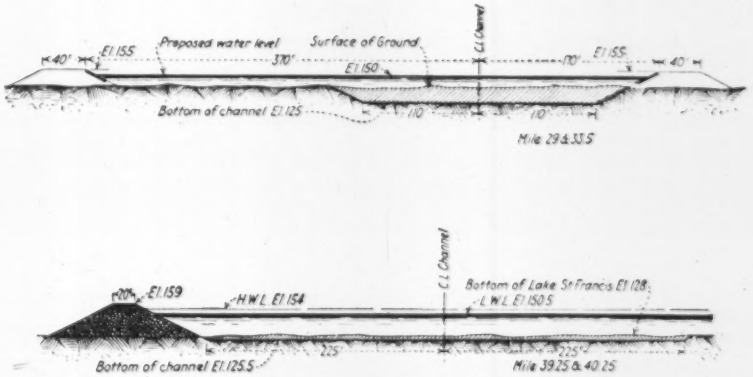
Maps, Profile and Cross Sections of Waterway and Power Development of

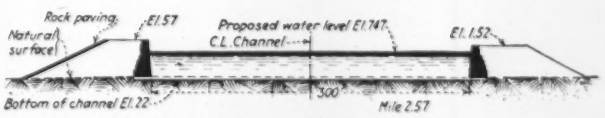
ed in Report to International Joint Commission by Col. W. P. Wooten, Corps of Engineers, U. S. A., representing the United States, and W. A. Bowden, Ch



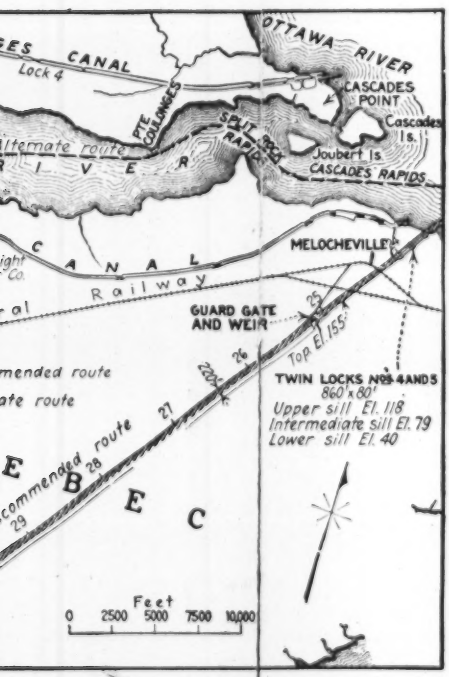
O POWER DEVELOPMENTS.

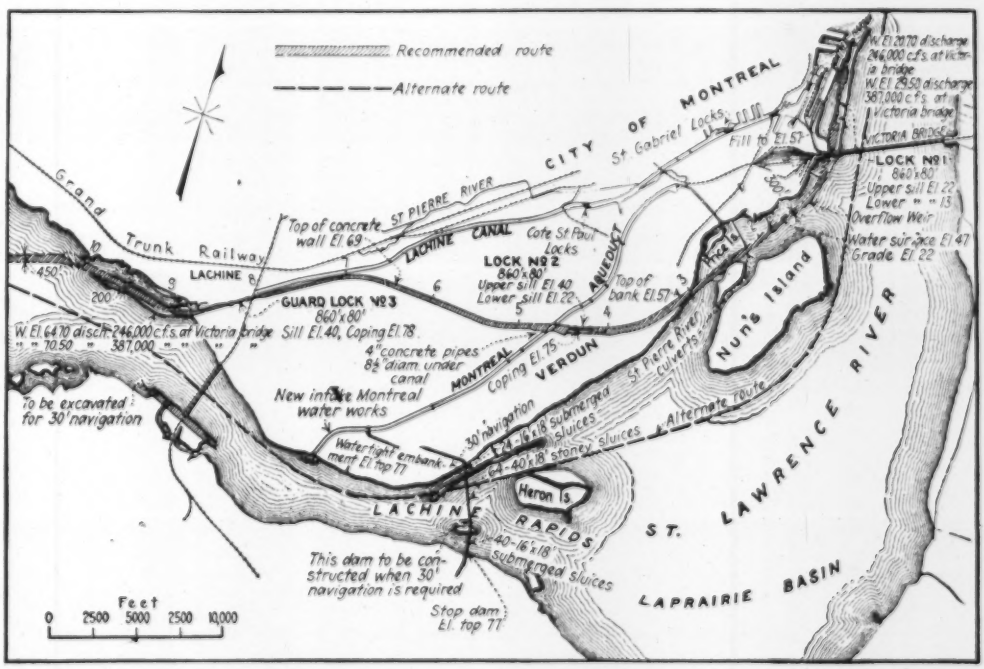






TYPICAL SECTIONS





ENLARGED MAP OF FIRST DIVISION

t of St. Lawrence River

n, Chief Engineer of Department of Railways and Canals, representing Canada

ice jams that form in the river below Montreal. As a source of power, other sites further upstream are much more economical; and for the improvement of navigation alone, the recommended scheme is over seven million dollars cheaper.

Second Division

This division, about sixteen miles long, connects Lakes St. Louis and St. Francis, and includes the Cascades, Split Rock, Cedars, and Coteau Rapids, having a total fall of 83 ft. at mean flow. There are several water-power plants now operating on this stretch of the river, which together generate about 180,000 hp.

The project that is recommended for the improvement of this division consists of a side canal, with locks on the south side of the river. The route leaves the shore of Lake St. Louis near the village of Melocheville, at an angle of 45 deg. and continues on this course until it is nearly four miles from the river. It then swings back, passing the town of Valley Field at a distance of two miles, and enters Lake St. Francis at Hungry Bay.

Near the lower entrance to the canal a double flight of twin locks is located, which raises the water level at once to a little less than that of Lake St. Francis at low stage. A guard lock is located near the upper end of the canal, about 6,000 ft. from the shore line of the lake. At high water this lock will have a lift of about 3 ft.

The estimated cost of the works for a depth of 25 ft., a least prism width at bottom of 220 ft. and with banks and bridges placed for a future widening to 400 ft. and locks and other structures designed for a depth of 30 ft. is $36,590,000. The annual cost of operation, maintenance, and depreciation will be $400,000. The estimated cost of deepening the canal in future so as to afford a depth of 30 ft. is $3,110,000. The development of the power in this stretch of the river can be made in future without interfering with the use of these navigation works. The amount of power that could be developed in this manner would be about 1,560,000 hp. and the cost is estimated at $151,688,000.

If the development of nearly 1,500,000 hp. were not contemplated in the fourth division, a combination navigation and power project would be advisable in this second division. This project would involve the construction of a dam across the river near the village of Cedars, to carry the level of Lake St. Francis, the excavation of navigation and power canals along the north shore of the river from the proposed dam to the Ottawa arm of Lake St. Louis, and the building of locks and of a power plant. The lower lock, having a lift of about 40 ft. would be located at the shore of Lake St. Louis, and another lock with the same lift would be built about a mile up the canal. To overcome the drop in the rapid water at the head of the Coteau Rapids, a guard lock, with a small lift, would be located a little below Broad Island. Above the guard lock a pool would be formed by dams connecting Grand, Thorn, Pig and Clark Islands.

The estimated cost of this alternate waterway for a depth of 25 ft., a least prism width of 220 ft. and with locks and other structures designed for 30 ft. is $49,709,000. The annual cost of operation, maintenance, and depreciation will be $400,000. The cost to deepen it to 30 ft. at a later date is $5,481,000, and the amount of power that could be developed by the construction of a power canal from the pool above the dam at Point Au Biron to a power house just north of Cascades Point, would be about 1,560,000 hp., and its cost is estimated at $124,468,000.

If the alternate method were adopted, the cost of the future development of power in this stretch would be $27,220,000 less than if the first method were adopted. Present injurious ice conditions in the river below would be mitigated by the adoption of this project. But these benefits would be secured by an increase in first cost of the navigation improvements of $13,119,000, and by an additional increase of $2,371,000 when 30 ft. navigation is required. The eventual saving would therefore be $11,730,000, but if the development of power were delayed more than 11 years, interest being taken at 6 per cent, the advantage in cost would lie with the first project. It is believed that the power recommended for development in the Fourth Division will meet all market requirements for more than 11 years. For this reason the project for an improvement by canal from Melocheville to Hungry Bay is recommended in preference to the alternate project.

Third Division

This reach is about 28 miles long, and comprises practically all of Lake St. Francis. It is proposed to dredge a channel 450 ft. wide and 25 ft. deep at low water wherever the same is not already obtained. The extent of the necessary work is not great.

The improvement of this Third Division, Lake St. Francis to the head of St. Regis Island, is the simplest of any on the project, as it consists practically entirely of dredging. The estimated cost of the recommended improvement is $1,158,000. The annual maintenance cost will be $30,000. An additional 5-ft. depth (same bottom width of channel) can be secured through this division at any future time, without interfering with navigation, and an estimated cost of $662,000.

Fourth Division

This division, from the upper end of St. Regis Island at the head of Lake St. Francis to Chimney Point, below Ogdensburg is 48 miles long. There are four rapids with swift water at other places which give to the division a total drop of about 92 ft. In the recommended project the first power development is located in this division taking advantage of the drop in the Long Sault rapids.

The recommended improvement makes excellent provision for navigation, gives safety to life and property below the improvements by providing two dams, either one of which is alone able to hold back the water in Lake Ontario, and develops a large percentage of the water power, with provision for the ultimate development of practically all the potential power in this stretch of the river.

The main features of this project are a series of dams at Long Sault Rapids and vicinity that will raise the water level to approximately El. 231, and a second dam at Ogden Island that will raise the level to that of Lake Ontario, less the necessary drop in the river. A short canal with two locks is combined with the lower dam, raising the water in the water way from the level of Lake St. Francis El. 152, to the pool level, El. 231; and another lock is provided at the upper or Ogden Island dam. A large power plant is located at the foot of Barnhart Isand, and a small power plant near the head of Long Sault Island. All structures in the vicinity of Long Sault Rapids are so designed that they may be

later raised to obtain at the power plants the greatest head that can be economically maintained.

From Lake St. Francis to the west end of Cornwall navigation will be imposed by extensive dredging, both to obtain the necessary sectional area for the boats using the waterway, and to reduce the velocities.

At the west end of Cornwall the course of navigation leaves the river and enters a canal. About 1,000 ft. from the shore is located the first lock, which raises the water level about 48 ft. to El. 200. The canal connecting the lower and the upper locks is about six miles in length. No rock is encountered in carrying excavation to grade and at the upper end the canal enters the lake on the Cornwall Canal which was created some years ago by the construction of dams at the head and foot of Sheek Island.

The upper lock is located on the north shore of Sheek Island, and will have a lift of about 31 ft. A dam will run from the lock, across the lake mentioned above, and abut on mainland above the village of Moulinette. A pair of guard gates will be installed about a mile above the upper lock, with dams running from them to high land on Sheek Island and on the Canadian mainland.

Dams in Fourth Division

The series of dams and other structures at the Long Sault Rapids extends from high ground on the Canadian side, across the intervening channels and islands, to high ground on the American side.

The most important of these are; a concrete dam across the Long Sault, about 3,900 ft. long, with spillway and control gates; a concrete dam and power house across the South Sault channel at a point between the head of the Massena Canal and the upper end of Long Sault Island; a concrete dam across the proposed diversion through Long Sault Island; and the Barnhart Island power plant. This plant located at the eastern end of the island, will contain 52 units, spaced 65 ft. center to center. Trash chutes will be placed at both ends, and at the angle in the center of the plant, and the total length of the structure will be about 3,800 ft. Connecting the concrete structures earth dams will be provided having a top width of 40 ft. at El. 243 and side slopes of 3 to 1. These earth dams will have concrete core walls extending to rock wherever the ground surface is below El. 220, and to an impervious foundation where the ground surface is between El. 220 and 232. Above El. 232 the earth embankments will not be provided with core-walls.

At Ogden Island, a concrete dam will be built across the north channel, consisting of a submerged gate section, 600 ft. of spillway, and a stoney sluice gate section. The lock which provides the lift from El. 231 to the level of Lake Ontario (minus the drop necessary to produce the river flow) is located just south of the island. A concrete dam containing stoney sluice gates extends from the lock to the south shore of the river. The approach channels both above and below the lock will require considerable improvement.

Above the last lock, the waterway follows the course of the river, except that the alignment is improved by a cut through Leishman's Point, at Rockway Point and Sparrowhawk Point. The section of the river from the lock to Galop Rapids is increased so as to give a velocity of 3.5 ft. per sec. at mean flow. Through the Galops Rapid the course of navigation will pass south of Lotus, Lalone and Galop Islands. By first improving the north channel and removing the Gut Dam between Adams and Galop Islands, it will be possible to cofferdam the south channel and to do the excavation in the dry.

The land flooded in the fourth division will amount to about 15,300 acres, of which 4,400 is on the Canadian side, 7,200 on islands, and 3,700 on the American side. The towns of Iroquois and Morrisburg will be protected by dikes, and the drainage of these towns will be taken care of by means of collecting basins and pumps.

The records of the St. Lawrence River since 1860 show a remarkably even flow. The level of Lake Ontario has varied from an extreme minimum of 243.21 in November, 1895, to an extreme maximum of 248.95 in May, 1860. The discharges corresponding to these elevations are respectively 191,000 sec.-ft. and 320,000 sec.-ft. In winter the flow drops below that ordinarily corresponding to the stage of the lake, due to ice effect. The lowest flow recorded is about 185,000 sec.-ft. A system of regulation of the flow of the river has been work out which makes it possible to increase the low flows without causing the lake to fluctuate beyond the limits set in the last sixty years.

Except for a very few periods of unusually long continued deficiency in supply, a flow of 210,000 sec.-ft. can be maintained. Of this amount 190,000 sec.-ft. will pass through the power plant at Barnhart Island, where a minimum head of 74 ft. is secured by the recommended project. The remaining 20,000 sec.-ft. will pass through the power plant at the upper end of Long Sault Island, under a head of 29 ft. Assuming an overall efficiency of 88 per cent, the power that will be generated at the Long Sault dam will be, as stated before, 1,464,000 hp. Each unit will pass 4,580 sec.-ft. under full gate opening and will deliver about 34,180 hp. to the bus bars.

Cost of Power Development

The project recommended provides a depth of 30 ft. in all lock structures and a depth of 25 ft. in channels except where a greater depth is required to discharge without unduly great velocities the water from Lake Ontario under the new conditions created by the works proposed. The estimated cost of this project, including the installation of hydraulic and electrical machinery for the development of the power, is $159,097,200. The power output will be about 1,464,000 hp. The annual cost of operation, maintenance and depreciation will be $1,762,000 of which $1,457,000 is properly chargeable to the development of power. The estimated cost for securing 30-ft. depth for navigation in the future is $1,270,180 additional.

A survey and estimate has been made of a side canal with locks leaving the river on the Canadian side below the city of Cornwall and entering it again opposite Chimney Point. It would be 45 miles long, with four locks. For 25-ft. depth in canal prism and 30-ft. depth in lock structures the estimated cost is $77,500,000. An additional cost of $10,100,000 would be incurred to deepen the canal reaches to 30 ft. This is considerably more than the estimated cost of an improvement of this division, however, by means of dams in the river, creating pools, and locks past the dams. For 25-ft. depth, the cost of improvement by this method would be $63,500,000. The construction of dams and locks without provision for the development of the water power that would otherwise be thrown away through the control gates would be for navigation alone an economic waste that should not receive serious consideration.

The execution of the project as recommended will

make it possible at a later date to raise the structures at Barnhart Island and to dredge the tailrace so as fully to utilize whatever head the operation of the works may show to be economically practicable. Furthermore, the construction of the Ogden Island dam affords a control over the level of Lake Ontario and the flow in the St. Lawrence River. This control can be exercised so as to raise the mean level of Lake Ontario without causing it to fluctuate beyond the limits which it has reached in previous years. But the studies which have been made of this problem fail to show that any very great increase in the natural low water flows can be made for the benefit of either power or navigation in Montreal Harbor and the ship channel below.

Fifth Division

This division is about 65 miles long, and the fall at mean flow is about 1 ft. The channel is generally deep and wide, except through the Thousand Islands where the minimum width is about 500 ft. The improvement of this division will require the removal of certain shoals, and the widening and straightening of the present channel. The estimated cost of the work is $100,000 and the annual cost of operation and maintenance is $20,000.

Ground Water Control on Drainage Project in Florida

Taintor Gates in Canals Hold Water at Different Levels in Different Soils and Pass Floods —Sand Foundations

By F. Teichman
Consulting Engineer, Wollaston, Mass.

CONTROL of the ground water level or water table in a drainage district by gates in the main canals, with the gate structures built on sand, is a special feature of the Lake Worth drainage district, which is the largest in Florida, having 130,000 acres in an area about eight miles wide and paralleling the coast for 24 miles.

Lake Worth and some smaller lakes along the Florida East Coast Canal are separated from the ocean by a narrow strip of land but are so connected with it that the water is brackish and at sea level, varying slightly with the tide. About two miles west is a chain of small lakes just inside the east boundary of the district, beyond which there is muck soil for about two miles and then six miles of sandy soil. The surface of the chain of lakes is at El. 10, which is the desirable ground water level for the muck soil, the sandy soil being at higher elevation and requiring a ground water level of about El. 16. This muck soil is well decomposed fibrous vegetable matter without silt, holding moisture readily, easy of cultivation and good for truck farming. The sandy soil requires generous fertilizing and is good for trees of the citrus variety. Heavy rains in Palm Beach county occur from March to June and August to December, the rains being largely local or covering a relatively small area for each storm. During June, 1919, for instance, the rainfall was 25 in. and during three days of March, 1921, it was 7 in. The canal system and its structures are figured for a run-off of 1 in. per 24 hours, giving extra capacity to the smaller canals that may have to carry the excessive local rains.

Main canals about two miles apart extend north and south, with laterals at right angles to these at ½-mile intervals. At the southern boundary is the Hillsboro Canal and two miles below the northern boundary is the West Palm Beach Canal, both being state canals from Lake Okeechobee and draining the Everglades. The district has connected its chain of lakes with Lake Worth by the Boynton Canal. In both this canal and the West Palm Beach Canal is a concrete outlet structure having square conduits with gates, the maximum head being 12 ft. This outlet on the district's canal has a discharge capacity of over 2,000 sec.-ft. A lock for boats is provided in the structure on the state's canal.

The area of the district is divided into eight units, all intersected by the main canals, which serve to spread the water of heavy local rains and thus relieve local flood conditions. In each unit is a control structure for holding the water at El. 16 for the sandy soil. Below this the water is at El. 10, the flow being through the

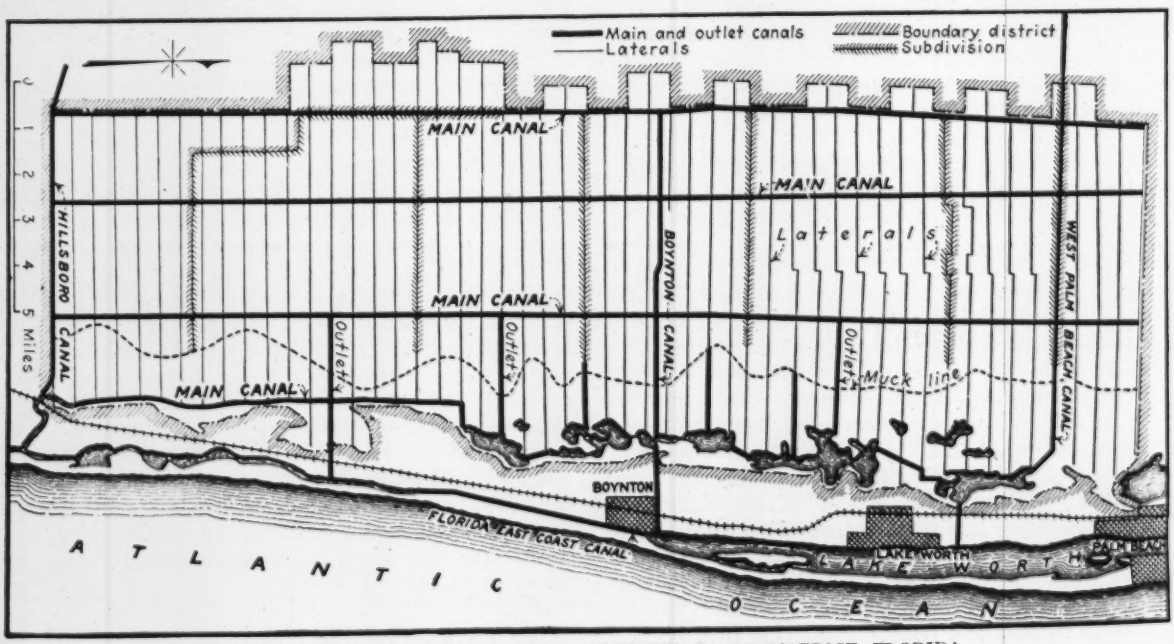


FIG. 1. CANAL SYSTEM OF LAKE WORTH DRAINAGE DISTRICT, FLORIDA

chain of lakes and thence through the Boynton Canal and its control works into Lake Worth. It is aimed to retain these levels during the dry seasons. When a wet season approaches, the water is held at lower levels which are more suited to crop requirements, when there is rain and which also help to keep down the peak line of floods. Thus before the March rainfall this year the gates of the Boynton control works had been opened more than a day on account of the weather predictions, so that the 7 in. of rain raised the water only 2 or 3 in. above its initial level. With an emergency flood storage capacity of 12 to 18 in. in the canal system and the chain of lakes it is expected that any excessive rains can be taken care of without overflow.

The control structure in the Boynton Canal is placed in a canal of 80 ft. bottom width, and has twelve square conduits fitted with Taintor gates, giving a head of 12 ft. and a discharge capacity of 2,400 sec.-ft. under 10-ft. head. On the upper drainage canals, the control structures have similar gates to support a head of 6 to 7 ft. during storage periods, the discharge capacity being equal to the flood flow capacities of the several canals, which ranges from 400 to 800 sec.-ft. The difference between upstream and downstream levels averages about 2 ft.

A Taintor gate is placed at the downstream end of each conduit, with stop planks above and below, as shown in Fig. 2. By removing the upstream stop planks a portion of the flood water may be passed over the closed gates in order to afford temporary relief until the gate operator arrives. Wood is used for the gates on account of the air on the Florida coast having a corrosive effect on steel. Each gate has a cast-iron rack and pinion, the pinion shaft having a square end for a portable ratchet lever.

All the structures are placed directly on the sand, giving a porous foundation problem similar to that discussed so frequently in connection with irrigation works in India and Egypt. The destructive agencies to be resisted by structures placed on sand are: (1) Uplift of insufficiently loaded parts of the structure; (2) sliding downstream of the structure under the effect of the head; (3) yielding of the sand if too heavily loaded and not confined; (4) piping at the tail end; (5) underwashing of the structure by the agitation of the stream at the tail end.

As to piping, the Indian rule is to make the creep under the structure of such length that the intensity of the creeping current is reduced to a value that at the tail, where the current returns through the canal bottom to the tail water, it will not move the particles of the soil. In "Practical Design of Irrigation Works," by W. G. Bligh, safe values for length of creep to head are given as 12:1 to 18:1. An inquiry directed to Mr. Bligh, giving the curve and the characteristics of the sand of the Lake Worth District, brought the reply that he approved of the adopted gradient 15:1, but that the theory of clinging creep, although originally emanating from Indian engineers (and represented in his books) is not now followed in India.

In this connection, it may be stated that the district structures were provided with gage tubes giving the uplift pressures in front and behind any sheet piling and about every 20 ft. of length of structure. The following results were observed: (1) For sheet piling at upper end of structure of about 10- to 12-ft. length the assumption of clinging creep gives results that nearly tally with observations; (2) For a driven curtain wall of 3 to 4 ft. at tail end of structure the loss of head is about twice that figured for clinging creep; (3) between upper and lower curtain the gradient is a straight line, as must be expected.

The theory and its application of neutralizing head by creep is by no means new in this country. Examples are found in structures of the U. S. Reclamation Service and probably elsewhere. The Reclamation structures have the advantage that they are located in silt carrying streams, so that after installation the condition of their safety improves by the formation of an upstream apron that increases its imperviousness by deposit from the seasonal silt-carrying flood waters. Although the streams and canals of Florida carry no silt it is not

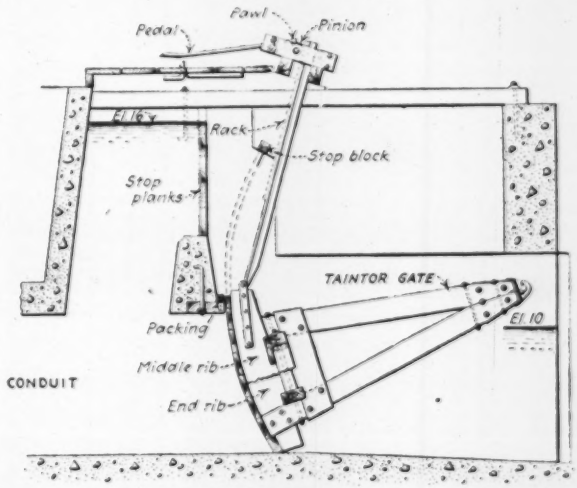


FIG. 2. TAINTOR GATES REGULATING GROUND-WATER LEVEL

unlikely that a slow sealing of the interstices of the soil takes place by decaying vegetable matter.

The Indian structures as described by W. G. Bligh and by P. M. Parker in his book "Control of Water" are works of greater magnitude. The weight of the structure to counteract uplift is attained by heavy concrete or masonry work in the river or canal bed, where, however, only about one half is effective, the other half being balanced by flotation. Such treatment is undoubtedly correct where large quantities of water have to be passed and where material and labor are cheap. For the Florida work the maximum discharge requirement is little more than 2,000 sec.-ft., rock has to be hauled for long distances and cost of labor is high. So the structures are built in reinforced concrete, with a combination of several conduits having a standard width of 5 ft. and of such height as conditions may require, the structures being filled over and loaded by the soil. This method of controlling the drainage, flood water and ground water level of the Lake Worth Drainage District will eliminate the two undesirable conditions of too much water and too little water.

The organization work and the laying out of the canal system was done under Orrin Randolph, former chief engineer. Construction work is in progress under F. C. Wagen, chief engineer, with Wills & Sons & McCarthy as contractors for the canal work and the structures. The writer has been the consulting engineer for the District and designed the works.

Pave 70-Ft. Boulevard with Sheet Asphalt

Mechanical Plant Features Reconstruction of 4¼ Miles of Ocean Parkway in Brooklyn —To Cost $750,000

THE largest continuous area of street paving ever placed under contract in the Borough of Brooklyn, New York City—representing a length of 4¼ miles and a surface of 164,000 sq.yd. of 3-in. sheet asphalt on a 6-in. concrete base—is being completed on Ocean Parkway between Park Circle, near Prospect Park, and Ave. W. The cost, based on the bid price, will be about $750,000. The route is the well known 70-ft. wide boulevard leading from Brooklyn to Coney Island and carries a heavy motor vehicle traffic, particularly on Saturday and Sunday during the summer when great crowds journey to the seaside resort. The paving work includes a concrete curb and gutter, and has been divided into three contracts of 2, 1¼ and 1-mile lengths. The chief point of interest is the unusually extensive use of mechanical plant on the 2-mile section known as Contract 1.

Ocean Parkway was constructed in the days when automobile traffic was negligible and the original surfacing of gravel and broken stone was subsequently treated with applications of ¾ gal. of asphaltic oil per square yard and covered with a thin layer of stone chips, forming a mat which reduced the dust nuisance. There was, however, no foundation course, with the result that as traffic increased the surface became extremely uneven.

In the reconstruction work the first operation consisted in removing the existing bituminous mat and the stone and gravel underneath, involving a maximum cut of about 1 ft. to prepare the subgrade for receiving the 6-in. concrete foundation. The table shows the principal quantities involved on the three contracts. Contract 1 was awarded to the Borough Asphalt Co. at a total cost of $363,653.75, amounting to a price per square yard of asphalt paving (including concrete curb and gutter) of $4.58; Contract 2 was awarded to the Cranford Co., of Brooklyn, at a total cost of $214,484.10, equivalent to $4.29 per square yard; Contract 3 was awarded to the Brooklyn Alcatraz Asphalt Co. at $165,804, equivalent to $4.81 per square yard. For the 163,950 sq.yd. of asphalt surfacing included in the three contracts the bid price averages $4.54 per square yard.

IN REMOVING OLD SURFACE THREE GRADING SHOVELS AND THIRTY-FIVE MOTOR TRUCKS WERE USED

TRACTOR GRADER LOADING TRUCK ALONGSIDE

TWO PAVING MIXERS ENABLED CONCRETING TO FOLLOW CLOSELY BEHIND GRADING ON 70-FT. BOULEVARD

FINISHING OCEAN PARKWAY RECONSTRUCTION WITH A 1-IN. BINDER AND A 2-IN. SURFACING OF ASPHALT

On Contract 1 a time limit of 75 working days was specified, but the contractor has been able to work at a rate 100 per cent faster than the contract requirements through the use of extensive mechanical equipment. The surface was broken up with plows hauled by steam rollers and the material removed in one of two ways: First, by an elevating tractor grader which made a cut 5-ft. 5-in. wide and had a rated capacity of 800 cu.yd. per 8-hr. day, and, second, by three steam grading shovels each with ½-cu.yd. dippers. Both types of machine loaded directly into motor trucks, of which a fleet of 35 5-ton machines was employed on the regulating and grading work alone. With this equipment an average day's work for the contractor in regulating and grading amounted to about 1,015 cu.yd. of material removed. The subgrade was rolled with two 10-ton rollers.

The scheme of construction involves close sequence between the grading, concreting and asphalt laying operations. To keep pace with the grading work and because of the great width of the boulevard, two paving mixers, each of 2/3-yd. capacity per batch, are employed, as shown in one of the photographs. Ten 5-ton motor trucks are employed exclusively in hauling concrete materials. The sand and broken stone are deposited in piles on the finished subgrade ahead of the mixers. Working an 8-hr. day each mixer has turned out, on the average, 1,470 sq.yd. of 6-in. concrete. The daily advance along the 70-ft. wide thoroughfare is, therefore, 378 ft. The concrete is mixed in proportions of 1:3:6. The concreting force serving the two mixers consists of one foreman and 56 laborers. The mixers are of the boom and bottom-dump bucket type and, side by side, easily command the 70-ft. width to be paved.

Asphalt surfacing operations follow along far enough behind the concreting to allow the foundation to set. The surfacing consists of 1 in. of binder and 2 in. of wearing surface. Nine 5-ton trucks are employed on hauling asphaltic materials to the job. The asphalt is brought to grade and rolled in the usual way; one 10-ton and one 5-ton roller are used.

On Contracts 2 and 3 less plant and more hand-labor methods are in evidence. The Cranford Co., however, employs one steam grading shovel, two 10-ton subgrade rollers six 5-ton motor trucks on grading work, two ¾-cu.yd. paving mixers, and ten 5-ton automobile trucks for hauling concrete materials.

On the third contract the Alcatraz Co. has one 10-ton subgrade roller, three 5-ton automobile trucks for hauling subgrade material, one concrete paving mixer ¾ cu.yd. capacity, and six 5-ton trucks for hauling concrete materials.

CONSTRUCTION QUANTITIES, OCEAN PARKWAY PAVING CONTRACTS, BROOKLYN, N. Y.

Item	Contract 1	Contract 2	Contract 3	Total
Grading, cu.yd.	28,000	7,570	6,900	42,470
Conc. foundation, cu.yd.	13,245	8,335	5,750	27,330
Sheet asphalt, sq.yd.	79,450	50,000	34,500	163,950
Conc. curb and gutter, lin.ft.	1,625	12,900	8,700	23,225

The work of paving Ocean Parkway is being done under the direction of the Department of Parks of the Borough of Brooklyn, of which John N. Harman is commissioner and E. J. Mullane, engineer in charge.

Water-Works Cross-Connections at Hartford, Conn.

George W. Goethals Corporation Reports in Favor of Improved Type of Double Check Valves Under Certain Conditions

AN ORDER by the Water Board of Hartford, Conn., requiring the elimination of all cross-connections between the city water-works system and private supplies from independent sources led a number of large manufacturers of that city to engage George W. Goethals & Co. to report on the subject. Specific questions at issue were the adequacy of "improved check valves" to prevent a menace to health from secondary polluted supplies; whether the fire hazard due to the elimination of cross-connections would more than offset the health hazard due to their retention, and what action the manufacturers had best take in case the Water Board refused to rescind its order. The Goethals company reported that within stated limits, and with frequent inspections, reliance could safely be placed on an improved type of double check valve, with less menace to health than would be caused by the increased fire hazard due to the elimination of all cross-connections. The substance of the report, including a substitute plan for the manufacturers to propose in case the order is not rescinded and an alternative plan of action in the Water Board will not accept even the substitute follows:

We have examined the water connections of the following plants: Underwood Typewriter Co., Hartford Rubber Works, Pratt-Whitney Co., Billings & Spencer Co., Hartford Machine Screw Co., Johns Pratt Co., and New Departure Mfg. Co.

The piping layouts of these plants are so arranged that water for drinking, cooking purposes, hand basins, and, in instances, a percentage of sanitary closets, is drawn from the city main through separate metered connections, and are entirely separate and distinct from all other layouts within the plant limits. Water for sprinkler heads, hydrants and standpipes and certain percentages of sanitary closets is drawn from the city mains through 8-in. connections in which are installed the double check valves. The number of such connections vary from one to a maximum of five in the case of one plant. This system is generally independent of the individual industrial service supply from Park River. In certain plants cross-connections between the city and industrial water are in use protected by double hand valves and drains, so that under emergency conditions it is possible to get city water for the industrial work. In other cases the same result is obtained by actually placing short sections of pipe between the city and interior industrial supply piping.

The sprinkler and hydrant systems are in all cases connected with emergency fire pumps drawing water from the Park River or, as in one case, from an adjacent pond, as a secondary source of supply.

Public Health Paramount

It will not be disputed that safeguarding the public health is of paramount importance in the design, installation and operation of a modern water supply system, and that an adequate and dependable water supply always available for fire protection is in importance second only to the question of public health. Furthermore, a complete breakdown in the supply system of a city for more than a few hours reverses the relative importance of the above, and if there were a secondary polluted supply available, no city would hesitate to force such water through its mains. The relative importance of the question varies with conditions. As a practical matter, it would be wiser to attempt to maintain supplies of water which would meet all conditions of fire and water closet demands without interruption, than to attempt to maintain 100 per cent pure water, because the first is practically possible and the second is not. The present system of pipe distribution, the manner in which underground pipes are repaired and maintained, the unknown branches always found connected to city mains taking water from polluted sources, the installation of water closet flushometers direct connected to city mains, and other sources of possible contamination, prohibit the maintenance of theoretically pure water at all times.

As a matter of general policy the primary water supply of the city should not be connected physically to a secondary polluted supply, except and only to provide for fire protection in the event of temporary failure of the primary supply. Where such secondary supplies are available, cities have recognized the advantages and have permitted the connection of same to the primary supply, but only under the most rigid control, inspection and maintenance, and only for sprinkler and hydrant service.

To allow such connections in special cases and in limited numbers, the so-called double F. M. [Factory Mutual] check valve installation came into use about 1910 or 1911. This equipment has to date been recognized as a reasonably certain safeguard to public water systems by the officials of many cities and has been accepted as a sufficient and satisfactory safeguard by the Commissioner of Health of the State of New York. The Board of Health of New Jersey has recommended this arrangement in specific instances.

No one will deny that under certain conditions, occurring most infrequently in properly maintained installations, swing check valves leak; notwithstanding this, we do not believe authenticated instances can be cited in New England or elsewhere since 1912, which have resulted in contamination of the primary supply and where the presence of B Coli, if found, could not be traced to sources *other than check valves of this type properly installed and inspected.*

It will be understood that the proper installation of swinging checks of standard F. M. or improved type calls for practically static water condition in the pipes on the plant side of the valves, except under actual fire operations. For various mechanical reasons this increases the reliability of the valve.

We believe the F. M. valve is open to further improvement in design, and in our opinion the all-bronze type built by C. D. Rice, chairman of your committee [Committee of Manufacturers, Hartford, Conn.], is a step in this direction.

A criticism directed against the F. M. check valve installations is that they leak or are most liable to leak appreciably under pressures higher than the city pressure. Such can be the case only on the assumption of obstruction holding the seal up or the seal being partly torn away. This condition in a water line, static at all times other than in case of fire emergency, is an exceptionally remote possibility and indicates improper supervision. No one today condemns modern rapid mechanical filters on the basis that, if you do not properly operate and maintain them you will unquestionably get polluted water into your clear water well and thereby menace the public health.

If the above criticism is the principal one, it is perfectly feasible to install a special type valve at the fire pump that effects a physical separation during pumping operations between the secondary and primary supplies. This valve under no possible condition can leak to the primary side up to 150 lb. per square inch, and, hand or power operated can under no circumstances be so manipulated as to connect the fire pump direct to the city mains. This valve, in the event of poor adjustment, will leak to the atmosphere and present evidence of its adjustment at all times on its exterior. With this installation the F. M. check or improved design check should be installed back near the city take off to provide against the condition of city pressure dropping to a point where the dead head of water in the sprinkler heads would slowly settle back into the city mains unless checked. This system makes most improbable pressures in excess of city pressure reaching the check valves.

If the city of Hartford would eliminate all physical cross connections now existing between polluted secondary supplies and the city mains, and require the comparatively few double check control installations to be replaced with all-bronze body special design checks similar to Mr. Rice's design, with or without certain additions that might be suggested; and if the city would compel such installations to be on independent sprinkler head and hydrant lines with no cross-connections of any character; and, lastly, would continue the present system of weekly or bi-weekly inspection; then the danger to the public health would, in our opinion, be entirely negligible.

Such a policy would permit the continued availability of an inexhaustible secondary supply for fire protection, which far outweighs, in our opinion, a limited tank supply placed below ground, required if the valves are eliminated.

Conclusions

Our conclusions therefore are as follows:

1. The public health of the city of Hartford can be completely safeguarded with the continued use of a check valve system of improved design on the following basis.

a. Eliminate all city connections to secondary polluted supply wherever located, except existing connections to sprinkler heads, hydrants and fire pumps.

b. Eliminate all existing cross-connections running from sprinkler head or hydrant feeders to interior service and taken off on the plant side of check valves.

c. Install improved type of double swinging checks in self draining concrete vaults protected from frost and freely accessible for all purposes.

d. Maintain not less than bi-weekly inspection tests.

2. It may reasonably be stated that the increased fire hazard resulting from the elimination of a check valve system installed as defined immediately above would more than outweigh the remote danger to public health through the proper operation of such valve system.

3. There is no recognizable danger to the safety of the public health in the carrying of polluted water in extensions to city mains ending in hydrants and sprinker heads if no cross-connections are allowed and if check valves are installed as above.

4. In the event the city declines to rescind the present order or to modify it so as to allow the above recommendations to be followed, we propose the installation suggested [special valve at fire pump] and additional fire pumps sufficient to provide full plant protection and all necessary hydrant supply for a general plant fire, independent of city supply.

5. In the event the city declines this alternative, install smallest ground or elevated tank for sprinkler heads that will pass underwriters, and connect existing fire pump independently to exterior hydrant lines and standpipes, adding to the pumping equipment where necessary to give the full capacity of hydrants to the maximum number required.

The order of the Hartford Water Board that all cross-connections must be severed by Sept. 1, 1921, in accordance with a report and recommendations by Caleb Mills Saville, manager and chief engineer Hartford Water Department, was printed in *Engineering News-Record*, July 7, 1921, together with the larger part of Mr. Saville's report on the Subject. (See news this issue.)

Underground Water Supply for an Akron Rubber Plant

By Frederick L. Roache
Cleveland, Ohio

TO THE rubber industries a large supply of water is as necessary as rubber and the water must be cold. The demands of the four large rubber companies at Akron, Ohio, combined with the sudden increase in population, increased the water consumption beyond the capacity of the city supply, and compelled some of the rubber companies to develop water supplies of their own. A supply with a summer-and-winter temperature of 49 deg. F. was secured and has been delivered to the works at a unit cost of about one-third of the city rates.

The rubber company with which I was connected was located on a branch of one of the small rivers between Lake Erie and the Ohio River. A study of the rainfall and run-off of this small river was made. A 32-ft. concrete weir was built above the plant and a Frieze automatic stage-register was installed. The drainage area was about 43.4 sq.mi. The normal annual rainfall was 37 in. and the drainage area about 90 per cent cultivated. I estimated that the evaporation was 10 per cent, the run-off 20 per cent, amount absorbed by vegetation and used for domestic purposes, 30 per cent, leaving about 40 per cent as underground storage. Both the rainfall and the river flow were very erratic, with winter and summer periods of minimum flow. The minimum river flow in July was less than 1.23 m.g.d. and the total precipitation for the month was 1.98 inches.

After preliminary tests, made by driving 2½-in. pipe down to and 15 to 20 ft. into rock, securing samples, and plotting ground water profiles in the valley of 3 sq.mi. area above the weir, six wells, with 20-in. screens, were sunk to rock, which was found at depths of 102 to 149 ft. Pumping tests of the first well warranted sinking more wells, and like tests of the second well showed a yield of 1,649 gal. per minute. When five of the six wells had been sunk it was estimated that an average total of 3,500 gal. a minute could be obtained. A 24-in. (vitrified clay and cast-iron) pipe line, 6,000 ft. long, with a fall of 17 ft. to the plant, was built. It was assumed that this would be large enough to carry 1,000 gal. per minute additional, from a sixth well, by gravity, and that if necessary the pipe line could be put under a small pressure without lessening the yield of the wells. To meet the increasing demand for water, each of the five pumps was run at full capacity, giving a yield of 4,500 gal. a minute, and the sixth well was sunk. The total output under normal conditions, using six wells, was 5,000 gal. a minute.

The pumping plant consists of five 15- and one 20-in. American deep well pumps, operated by four 25-, one 20- and one 40-hp. motors, the latter driving the 20-in. pump. A novel and efficient connection between pump and motor (both shafts vertical) was made by the use of a pliable leather belt, which eliminated jar and excessive load in starting and allowed a small error in alignment.

The combined suction and supporting pipe and the discharge pipes have diameters of 10 in., except that for the 20-in. pump the diameters are 12 in. The water is discharged into baffled weir boxes, each equipped with a 24-in. rectangular weir. The weir boxes discharge into open manholes connected with the main supply line. The weir box was connected to still water wells in the pump houses, where Frieze automatic water-stage registers record the entire flow over a weir.

The pump houses are of wood, 14 x 16 ft. in plan, with pitch roof, and a concrete floor and pump base. For removing the pumps and cleaning the wells each pump house is provided with a trolley crane running on a 15-in. I-beam placed just beneath the ridge pole and supported by an A-frame independent of the roof purlins.

Electric current was carried from the plant power house—2,200-volt, a.c., three-phase, 60 cycles—and reduced in voltage at each well house to 440 volts. This current was metered at each well.

The pump houses were successfully warmed during a severe winter by two electric heaters in each. The 1½-in. pipe line from the weir box to the still well in the pump house was warmed by a frost box in which were installed four 110-volt light bulbs in series. Carbon filament bulbs were used because they gave more heat than bulbs of later type.

An accurate account of the maintenance costs was kept. Combining these with 10 per cent for depreciation and repairs, and 6 per cent for interest on the whole investment (excluding land values, as the land was used for other purposes), the cost ranged from 13 to 17c. per 1,000 cu.ft., varying with the amount supplied, or about one-third the city rates. Besides the saving in cost, water with the desired low temperature throughout the year was obtained. Bacterial tests of the water from each well showed a total count of from 8 to 12 per c.c., except that one well showed 40 bacteria.

Concrete Barges in Austria

The construction of concrete ships and barges in the United States has practically ceased, but apparently the industry is continuing in Europe, for a note has just been received from V. C. Lazarus, of the Syndicate for Ferro-Concrete Ships, of Vienna, stating that on July 3, a large reinforced-concrete barge was launched at Krems, Austria, for use on the Danube River. This is a 700-ton dead weight and has the same hull design as the steel barges normally used on the Danube. Information regarding the dimensions of the barge is not available.

Special Structural Design for Newspaper Building

Lower Chord of Steel Roof Trusses Will Form Future Floor Reinforcement—Unit Loads Varied On Floors

TEMPORARY steel roof trusses, independent press foundations and floor design for light and heavy loads in different parts of the building are structural features of the new reinforced-concrete building for the *South Bend Tribune* at South Bend Ind., which has been designed for the combination of office and industrial requirements of a newspaper publishing business. An unusual feature of the roof construction is that the present trusses will be removed when additional stories are built, the bottom chords remaining in the floor (now the roof) and intermediate columns being placed under them.

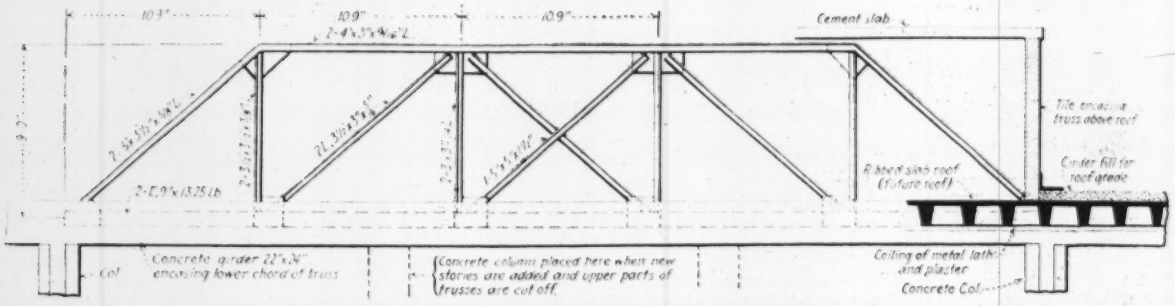
This building is three stories high but designed for three additional stories. Storage for 1,000 tons of press paper is provided in the basement, which has also a boiler room, 100-ton coal bunker, fire-proof vault and locker room with toilets and shower baths. On the first floor are the business offices in front and the press and mailing room at the rear, separated by a hall in which the newsboys get their papers. Behind the press room is a 14-ft. driveway, under the second floor, extending from the alley to the street and having doors at each end. An electric overhead hoist lifts the 750- to 1,200-lb. rolls of paper from trucks in the driveway and lowers them into the basement, where they are handled by a small electric truck with a stacking attachment. On the second floor are the editorial offices, composing room (54 x 64 ft.) and stereotyping room (33 x 54 ft.). An assembly room 60 x 60 ft., with dining room and kitchen at the rear, occupy the main part of the third floor, these facilities being mainly for the use of the employees. Brown, rough-faced brick is used for the exterior walls, with steel and gray granite and terra cotta trimmings.

Interior columns are omitted in the assembly room, in order to give an unobstructed space, the roof slab being supported over this part of the floor by steel trusses of 54½-in. span, whose lower chords are embedded in concrete girders. Above the roof slab (or future fourth floor) the trusses are inclosed in a tile superstructure with concrete roof. When the additional stories are to be built, the upper part of each truss will be removed by cutting the web members at the top of the concrete floor slab, new concrete columns being then placed under and upon the girders to continue the columns from the lower floors, as shown by the dotted lines. The bottom chord will remain as reinforcement in the concrete girders.

Floor construction is mainly of the ribbed slab type, with the ribs concealed by a ceiling of metal lath and plaster. Sheet steel inverted troughs 20 in. wide are used to form the 5-in. ribs, spaced 25 in. c. to c., the depth of the rib being 12 in. with a 2-in. slap on top. An exception to this construction is the stereotyping room, where a 5-in. slab and girder design is used on account of the weight of the furnaces or melting pots. This part of the floor is designed for a live-load of 500 lb. per square foot, and the composing room (with heavy typesetting machines) for 300 lb.; elsewhere the load is 150 lb.; except that for the offices it is only 100 lb. The floor panels are mainly 18 x 22 ft. c. to c. of columns.

Foundation conditions are simple, the site being on a deep bed of sand and gravel, so that the footings are just beneath the basement floor, the load limit of the footings upon the material being 6,000 lb. per square foot.

A special foundation for the 60-ton press, inde-


10'9"
10'9"
10'9"
Cement slab
Tile encasing truss above roof
Center fill for roof grade
R'fored slab roof (Future roof)
Concrete girder 22"x36" encasing lower chord of truss
Col
Concrete column placed here when new stories are added and upper parts of trusses are cut off
Ceiling of metal lath and plaster
Concrete Col.

STEEL ROOF TRUSSES TO BE REMOVED WHEN STORY IS ADDED

pendent of the building foundations, consists of a pair of massive concrete girders, connected by transverse beams and supported on short columns. The floor under the press is level with the first floor slab, but isolated from it by a space 8 to 30 in. wide, covered by steel plates, so that vibration due to the machinery will not be transmitted through the building.

To remove the hot gases and fumes from the stereotyping room the melting pots have hoods connected by metal pipes to flues built on the inside of the rear wall. In addition, a ventilating shaft 3 ft. square extends from the middle of the ceiling to the roof, where it is capped with an exhaust head. When the additional stories are built this shaft will be carried up to the new roof. For general ventilation of the first and second floors there is a fan in the basement, delivering fresh air through galvanized iron risers cased with hollow tile. A fireman's pole placed near the press and extending from the second floor to the basement, is an unusual appliance installed to enable men to drop rapidly from floor to floor without taking time to go round by the stairs. A pneumatic tube system serves the several departments. Sprinkling equipment for fire protection is connected to an outdoor nozzle for the attachment of fire hose.

In the design of this building the architects, Austin & Shambleau, South Bend, Ind., were guided by floor layout plans prepared by F. A. Miller, editor and vice-president of the *Tribune*. The H. G. Christman Co., also of South Bend, had the contract, with R. G. Taft as superintendent of construction.

Test Bearing Strength of Bolts Through Concrete Beam

By S. C. Majumdar
Structural Engineer, H. M. Lane Co., Detroit, Mich.

During a recent investigation of the strength of a number of monorail supports in an industrial plant it was necessary to assign definite values to bolts which had been cast into concrete beams. These bolts extended horizontally through 15 in. of concrete and supported clip angles at one or both of their extremities. The load being applied at the clips, bending was introduced in the bolts preventing a uniform bearing in the concrete. In addition there was a slight eccentricity in the application of the load to the clip angles. The exact amount of eccentricity which was transmitted to the bolts depended somewhat upon the stiffness of the connection between the monorail beam and the clip, the assumption being that the clip would act as a cantilever

FAILURE OF TWO 1-IN. BOLTS UNDER TEST LOAD OF 21,500 LB.

and tend at least partly to produce a vertical load rather than a rotation about the far bolt. In view of these complications it was decided to make an actual test.

Two 1-in. bolts placed 5½ in. above the bottom of the beam were used, the concrete having been poured about 8 months. An attempt was made to approximate as nearly as possible the exact conditions, both as to stiffness and eccentricity. To the standard clip angle shown at the top, in the accompanying view, was bolted a hanger consisting of two angles 4 x 3 x ⅜ in. by about 12 ft. long, on the bottom of which was hung, by means of steel cables, a loading platform. This platform was made up of two 12 x 12 in. timbers 12 ft. long, covered with 3-in. plank, and was guyed in each direction to prevent swinging during the process of loading. A level was also applied to the vertical hanger to insure a concentric loading on the platform. As pig iron was piled on the platform and the cables straightened out and adjusted themselves to the load, shims were placed under and kept to within a couple of inches of the main timbers to prevent too great a drop when the failure occurred. This precaution was taken to prevent a sudden impact on the reinforcing bars in the concrete beam with a possibility of destroying their bond.

Failure occurred at 21,500 lb. and took place several minutes after the last pig was applied. Although the concrete was worth considerably less in bearing under the bolts than in shear the ultimate failure was evidently one of shear. The beam had been previously painted and it was impossible to detect any cracks that may have developed prior to failure. If any such cracks were present they were too small to break the surface of the paint.

Had it been possible to design the above connections, using vertical bolts in direct tension instead of bearing, the same bolts would have developed an ultimate strength of at least three times as great as they did.

Man-Hours and Material Cost Data for Cast-Iron Pipe Laid

By Leo G. Hall
Onekama, Mich.

The accompanying table showing the number of man-hours and the amount of material per 100 ft. length of 4- to 36-in. cast-iron pipe laid on a number of jobs is similar in form to the valuable series of tables for various classes of building operations contributed to *Engineering News-Record*, May 26, p. 888, by Frank E. Barnes.

My table is based upon (1) direct observation of work on water mains for the General Chemical Co., Marcus Hook, Pa.; for the Camp Hill Embarkation Cantonment and Warehouses, Newport News, Va.; the Willys Corporation, Elizabeth, N. J.; and (2) upon indirect data from a number of industrial and railroad yard construction jobs with which I had no field connection. The pipe used was of the Class C type.

DATA FOR ESTIMATING COST OF CAST-IRON PIPE IN PLACE

Size of Pipe, In.	Hours Labor per 100 Ft. Pipe per Foot of Depth: Soft Clay, Loam or Sand	Hard Clay, Shale or Hardpan	Laying Pipe	Jointing and Caulking	Materials per 100 Ft. of Pipe, Lb.: Pipe	Lead	Oakum
4	24	40	5	4 5	2,200	50	1 9
6	27	44	8	7	3,600	70	2 8
8	30	47	11	9	5,200	95	3 8
10	34	54	16	11	7,100	125	4 6
12	38	*61	22	17	9,300	160	5 5
16	*48	75	32	28	14,400	210	8 0
20	64	*106	48	38	20,400	265	11 0
24	*80	*130	*75	*50	27,500	325	13 5
30	98	157	90	62	39,900	430	19 0
36	120	*190	110	76	54,600	650	26 0

Figures marked with an asterisk were arrived at by interpolation. The considerable divergencies in some of the original figures could usually be traced to special circumstances, and allowances were made accordingly in striking an average. The figures show about what may be expected of an average well organized gang on a large job, with no special difficulties to overcome.

The widest divergencies appear under trenching. The figures given are intended to represent average performance in trenching between the depths of 2½ and 6 ft. only, where little pumping and no sheeting is required. At depths exceeding 6 ft., the cost increases much faster than the depth. Trenching here includes bellholes and backfill. Quantities of lead and yarn are sufficient to take care of a small amount of wastage which always occurs on a construction job.

As to fittings, experience shows that it is best to allow the cost of 10 ft. of straight pipe for each ell, tee or wye and 20 ft. of straight pipe for each double wye, cross or special fitting. Such expenses as hauling, superintendence, etc., are not susceptible of being tabulated in compact form and are therefore omitted.

Use of Photography in Hydraulic Measurements in India

Photographic Tests Made on Large Jets Check Remarkably Close with Actual Gagings by Current Meter

By S. C. Majumdar.
Executive Engineer, Public Works Department, Madras, India

In *Engineering News-Record*, July 8, 1920, p. 62, Pierce J. McAuliffe describes experiments made by him to measure the velocity of discharge through hydraulic dredge pipes. Practically similar methods were adopted by the writer in January, 1919, to determine the coefficient of discharge through sluices working under high head. The result then obtained has now been verified by actual gagings.

The sluice experimented upon is one of the eight scouring sluices in the Krishnarajasagara dam which is being constructed by the Mysore State across the Cauvery, one of the largest rivers in southern India. The dam is to be raised ultimately to a height of 124 ft. from the river bed, but at the time the experiment was made water could be stored only to a depth of 63 ft. The sill of the sluice is 12 ft. above the river bed and the tunnel in the rear of the 6 x 12-ft. shutter 77 ft. long and 6 ft. wide. Even when the shutter is raised fully the water surface in the rear is below the springing level of the tunnel archway, the section of the waterway being a perfect rectangle 6 ft. wide at the sill. The bottom and sides of the tunnel are paved with first class ashlar masonry and there is no splaying at the ends. The water issues out of the tunnel in a fine jet and falls freely into the air. There is neither bottom nor side contractions but the main body of the jet is covered by very fine sprays at the top. For some distance after it leaves the tunnel and where it is not covered by sprays the sides of the jet are found to be in vertical planes interspersed with well defined rays formed presumably by the horizontal joints of the masonry at the mouth of the tunnel. These parabolic rays are visible even with the naked eye along the whole depth of the jet.

Determining Coefficient of Discharge

The problem of finding the value of the coefficient of discharge through these sluices has been engaging the attention of the Governments of Madras and Mysore during the last three years. The only site available for gagings was about two miles below the dam, where the river flows in three branches, the total width being about 3,300 ft. The velocity is necessarily low and and results obtained in 1918 and early in 1919 had to be rejected being most erratic. It was only at the beginning of the present year that all the difficulties could be satisfactorily overcome and the gagings made then with Fteley current meters were found to be fairly reliable.

When the gagings were in progress in 1918 the writer, who was in charge of these operations, proposed an alternative method to find out the value of the coefficient of discharge. The theory underlying the method is well known, viz., that when water falls freely into the air with an initial velocity, as is the case in the present instance when the discharge leaves the tunnel, it follows the path of a parabola and if the co-ordinates of this parabola are known the velocity of the issuing jet can be determined by eliminating t from the equations, $vt = x$; $\frac{1}{2}gt^2 = y$, where v = velocity in feet per second, t = time in seconds, x = horizontal co-ordinate in feet and y = vertical co-ordinate in feet.

But the problem was to measure these co-ordinates. Direct measurements were impossible, for, apart from personal risk to the observer, results even roughly approximating the truth could not be obtained owing to the presence of fine sprays on the top of the jet. It therefore occurred to the writer to take a photograph of the profile of the jet and it was believed that the sprays would appear in the photograph in a lighter shade and as such it would be possible to distinguish them from the main body of the flow. It was also expected that a good photograph would show the parabolic rays on the side of the jet and it would be possible to determine the velocity not only at the top and bottom but also at intermediate points of the jet.

As expected the sprays in the photograph (taken Jan. 18, 1919) could be clearly distinguished for some distance and the path traced by the top layer of the jet could be clearly located. In addition, one of the rays leaving the tunnel at a depth of 3.2 ft. from the surface could be clearly distinguished and its path could be traced till it met the water surface of the river. The

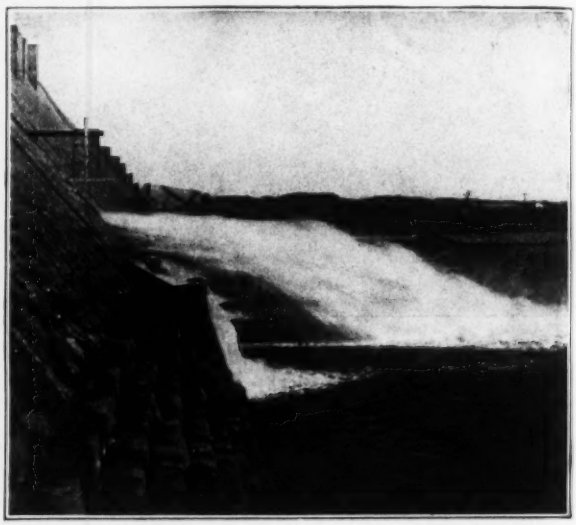


FIG. 1. SCALE AND JET FROM SLUICE

path traced by the bottom layer of the jet could not be distinguished quite so clearly, as the insufficiency of light caused this portion of the photograph to be somewhat hazy. This was not serious, for most of the discharge is confined within the paths which could be clearly traced and as such an error in the measurement of velocity at the bottom can only affect the estimation of the total discharge to a small degree. To avoid this difficulty an alternative method is suggested, viz., to assume that the velocity changes uniformly with the depth and to deduce the velocity at the bottom from the known velocity at the surface and at 3.2 ft. depth of the jet respectively. The results were worked out by both methods.

In order that the sprays may be clearly distinguished from the main body of the jet no lines have been drawn in the photograph. But the three parabolic paths have

been reproduced in the drawing, with the help of the co-ordinates actually measured from the photograph. Just above the jet a scale arranged in the shape of inverted *T* will be noticed. This was fixed in the plane of the front profile of the jet which was photographed and all the measurements have been made with this scale, viz., the abscisses measured with the horizontal scale and the ordinates with the vertical scale.

Two sets of co-ordinates have been measured for each of the parabolas, at points marked A_1, B_1 and C_1 and those marked A_2, B_2 and C_2. The velocities as obtained by either set agree closely; the slight difference may be due either to the error in measurement or to imperfect draftsmanship. The latter cause is more probable in the case of the points A_2, B_2 and C_2, (1) because at the point A_2 the sprays are very prominent and cannot be distinguished quite so clearly as at A_1, and (2) because the points B_1 and C_1 where the parabolas meet the river surface can be more clearly located than those lying higher up on the curve. For this reason the writer is of the opinion that the velocity worked out from the co-ordinates of the points A_1, B_1 and C_1 should be more reliable. In any case the discrepancy in the values of the coefficients as given by either set of co-ordinates is very slight and, as will be noted below, is within the range of values obtained as a result of actual gagings most carefully conducted.

Calculations—When the photograph was taken the shutter was raised 3.4 ft. above the sill, giving an effective head of 48.03 ft.

The co-ordinates of the points measured directly from the photograph with the scale shown in the picture and the velocity calculated therefrom are as follows:

At A_1 x = 22.8 ft. = vt.
y = 3.7 ft. = $\frac{1}{2}gt^2$
v = 47.40 f.p.s.
At A_2 x = 29.5 ft. = vt.
y = 6.4 ft. = $\frac{1}{2}gt^2$
v = 46.64 f.p.s.
At B_1 x = 19.8 ft. = vt.
y = 9.8 ft. = $\frac{1}{2}gt^2$
v = 25.30 f.p.s.
At B_2 x = 11.2 ft. = vt.
y = 3.2 ft. = $\frac{1}{2}gt^2$
v = 25.04 f.p.s.
At C_1 x = 13.6 ft. = vt.
y = 9.3 ft. = $\frac{1}{2}gt^2$
v = 17.84 f.p.s.
At C_2 x = 6.8 ft. = vt.
y = 2.7 ft. = $\frac{1}{2}gt^2$
v = 16.56 f.p.s.

The depth of the jet measured on the sill at the extreme end of the tunnel is as follows: AC = 3.7 ft., AB = 3.2 ft., BC = 0.5 ft.

The area of waterway between A and B is therefore 19.2 sq.ft. and that between B and C 3 sq.ft.

The total discharge as given by the velocities worked out from the co-ordinates of the points A_1, B_1 and C_1 amounts to

$$\frac{47.40 + 25.30}{2} \times 19.2 + \frac{25.30 + 17.84}{2} \times 3 = 762.6 \text{ sec. ft.}$$

Equating this to the usual sluice formula $CA\sqrt{2gh} = 762.6$, where h the effective head = 48.03 ft. and A = 20.4 sq.ft., the value of C, the coefficient of discharge, is found to be 0.674.

Similarly the value of the coefficient as worked out from the co-ordinates of the points A_2, B_2 and C_2 is found to be 0.664. By adopting the alternative method referred to above the value of the coefficient as given by the co-ordinates of the points A_1 and B_1 is found to be 0.680 and that given by the co-ordinates of the points A_2 and B_2 is found to be 0.67.

Gagings were conducted about a year after the photograph was taken. The water level in the reservoir was practically the same and there was no material difference in the effective head of discharge. The range of heights of shutter openings during the gaging period varied from 1.4 to 3.7 ft. and the coefficients from 0.641 to 0.700. But on a careful examination of the results it was found that the variation in the height of shutter opening had no effect on the value of the coefficient found except when the shutter was opened fully or at any rate the effect was so slight that it was covered by the unavoidable error in gagings. It has therefore been proposed to accept the mean value of the coefficient, 0.673, as being more reliable than that given by any of the individual gagings. The values of the coefficients as worked out from the co-ordinates measured from the photographs agree with this value remarkably closely, being 0.674 when calculated from the co-ordinates of points A_1, B_1 and C_1, 0.680, by the alternate method on the same points; 0.664 by A_2, B_2 and C_2, and 0.670 by the alternate method on the latter points.

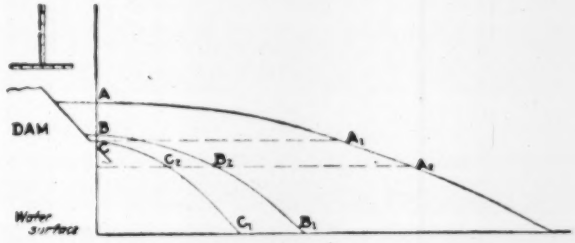


FIG. 2. PATH OF RAYS DECIDED UPON

On the day when the photograph was taken the weather was fairly calm and in addition the issuing jet was protected from the wind by the high dam. But that there was frictional resistance offered by the air is evidenced by the formation of sprays on the surface of the jet. Theoretically, this should cause some error in the application of the equations of the parabola which do not take into account this additional force. But that this error is insignificant is demonstrated by the close agreement of the result with that obtained from actual gaging.

In conclusion it may be stated that the accuracy of the method depends to a great extent on the skill of the photographer. In the present case the services of a local photographer only could be procured. The photograph is not quite so good as could be desired as only one intermediate ray can be clearly distinguished and the lower portion of the photograph is somewhat hazy. The photograph could have been improved upon by providing a dark background and lighting the lower portion of the jet artificially. The accuracy of the measurements of co-ordinates depends on the size of the photograph and a more satisfactory result can be obtained by using a camera of larger size. It has also occurred to the writer that measurements can possibly be more accurately made by projecting the view on a screen, but the method has not yet been tried.

Mechanical Filtration Plant Being Built in Cambridge

Water Purification at Massachusetts City Includes Coagulation, Sedimentation, Aëration and Chlorination

By George A. Johnson,
Consulting Engineer, New York City

THE mechanical filtration plant of 14 m.g.d. capacity now under construction for the city of Cambridge, Mass., is the first of its kind to be built in Massachusetts, and is more than twice the size of the one at Bangor, Me., the largest plant of this type heretofore built in New England. The Cambridge plant includes a covered sedimentation basin, filters, aerating and chlorinating devices for the filtered water, a covered clear water basin, a wash-water receiving basin, from which water is sent back to the settling reservoir, and low-lift pumps to deliver stored water from Fresh Pond to the filters, when the gravity flow to the pond fails to meet the demand. The structures are mainly of reinforced-concrete flat-slab and beam-and-slab type, with brick walls above the first story and concrete roofs.

The population of Cambridge was about 110,000 in 1920, and some 92,000 two decades earlier. In the same period the water consumption increased from 79 to 100 gal. per capita.

Reservoir System

Cambridge has a surface water supply, impounded in large reservoirs and subjected to a further period of long storage in a receiving reservoir. From the latter, the water is pumped to the city, in which there is an equalizing reservoir. The total storage capacity in the two impounding and the one receiving reservoirs is 3,092 m.g. Of this, 2,338 m.g. is provided by the Hobbs Brook reservoir, 354 m.g. by the Stony Brook reservoir and 400 m.g. by the Fresh Pond receiving reservoir. The water stored in the Hobbs Brook reservoir flows down the natural channel to the Stony Brook reservoir. From this reservoir to Fresh Pond the water flows through 7.53 miles of closed conduit. The population on the 23.57 miles of drainage area tributary to the two storage reservoirs is about 2,800 or 119 per square mile. Fresh Pond has a drainage area of about a mile on which there are some 8,000 people, but a bank protects the pond from surface drainage.

The reservoir system as a whole provides a long storage period, which affords considerable reduction of color and bacteria, but algae in Fresh Pond sometimes cause much trouble. Ample regulations for the sanitary protection of the water supply have been made. The swampy areas that give rise to color have been reduced and this work will go on. Measures to lessen algae growths will also be prosecuted. Fresh Pond water, as delivered to the pumps, has an average turbidity of about 10 p.p.m.; a color averaging about 25 with a maximum of some 40; and an average hardness of 30 p.p.m. of which about half is temporary. Notwithstanding these relatively favorable conditions, provision of a complete water treatment plant has been thought wise and designs for it have been made by the writer, who has been consulting engineer to the water board since 1915. Contracts for the plant were let June 28.

The filter plant site has an area of 1.6 acres, near Fresh Pond. The filters will be supplied so far as possible from a weir chamber at the lower end of the conduit now feeding Fresh Pond. Any deficiency will be made up by a low-lift pump connection with present suction pipe from Fresh Pond. The structures are mainly of reinforced concrete of flat-slab and beam-and-slab type. The superstructure above the first story is brick and the roof is of concrete.

Sedimentation Basin.—The sedimentation basin is a covered reservoir 96 x 137 ft. in plan and 16 ft. in effective depth. It covers approximately 0.3 acre of ground, and has an effective capacity of 1.5 m.g., or 2.5 hours' flow when the filters are operating at full capacity. The basin is divided into two equal parts arranged so that either can be taken out of service at will for cleaning, or otherwise to suit operating conditions. A distributing weir and a downward baffle are provided at the inlet end, and a surface take-off or skimming weir at the outlet end. Distributing pipes for returned filter wash water are located on the bottom of the basin just beyond the baffle at the inlet end. A sludge pump, overflow and gate chambers complete the equipment of the sedimentation basin which is separated from the clear water basin by a 20-ft. bank to guard against any contamination of the filtered water through slight leakage from this source.

Filters.—There are ten filter units laid out in one row with pipe gallery and operating platform along one side. A concrete flume, which receives coagulated and settled water from the sedimentation basin through a 48-in. pipe, traverses the length of the pipe gallery and supplies all of the filters. The filter tanks are monolithically constructed, each 20 x 24 ft., by 9 ft. deep, with a filtering area of 480 sq.ft. and a filtering capacity of 1.4 m.g. per 24 hours when filtering at the rate of approximately 2 gal. per square foot per minute, or 125 m.g. per acre per 24 hours.

The filtering materials will be about 27 in. of special filter sand overlying 9 in. of graded gravel. The filter equipment is in general conformity with customary practice, except that the pipe sizes are made somewhat larger. The Wheeler filter bottom is to be used.

Filter Bottom.—The filter floor, of the type known as the Wheeler bottom, consists of closely arranged rows of pyramidal depressions, each 5.5 in. deep and 8.8-in. base, with a ¾-in. brass tube 1.5 in. long set at the apex, for the connection and discharge of the filtered water or the admission of wash water from the channels or filtered water collectors below. In each pyramidal depression are placed five 3-in. solid cement spheres, one at the center and apex of the ¾-in. opening, and four in an upper layer.

Wash Water Receiving Basin.—Partly to guard against overloading the adjacent city sewer at inopportune times as well as to conserve the limited water supply the dirty wash water flowing from the filters will be discharged through a 20-in. line into a 37½-ft. covered circular concrete tank 10 ft. deep. As soon as filter washing commences the wash water return pump is started, taking suction from a sump in the receiving tank and returning the wash water through a 12-in. pipe to the inlet to the sedimentation basin. A 12-in. overflow from this tank leads to the city sewer.

Clear Water Basin.—The 4-m.g. covered clear water basin is 147 x 274 ft. in plan and has a maximum depth of 13 ft. of water when the aerator is in operation. It holds three hours' supply to the main pumping station,

and is designed to meet the requirements of the Fresh Pond pumps, which operate at the rate of 20 m.g.d. for 16 hours, and stores enough filtered water to make up the deficiency of the filters during the regular 16-hour pumping period. One side of the clear water basin extends under the filters. A filtered water conduit runs under the pipe gallery and is arranged so that the clear water basin can be by-passed if necessary.

Aerator.—The aerator consists of sloping concrete slabs in which are fastened short baffles arranged herring-bone fashion. These baffles retard and overturn the water flowing over them so that it receives a very thorough exposure to the air. Free carbonic acid and offensive odors are released from the water and dispersed into the air in this manner.

Chlorination.—A separate room is provided in the head house for the apparatus and operation incident to the chlorination of the filtered water. The chlorine will usually be applied to the filtered water after it has passed over the riffle aerator, but provision is also made for its application at the outlet of the filtered water conduit whenever the clear water basin is not in use.

Pumping Equipment.—There are provided one 4 m.g.d., two 6, and one 10 m.g.d. horizontal centrifugal pumps to supply raw water from Fresh Pond to the sedimentation basin when the gravity supply from the 63-in. conduit is insufficient. These can be operated in different combinations so as to deliver very nearly whatever quantity of water may be required. In addition, two horizontal centrifugal pumps, each of a capacity of 1,100 gal. per minute, deliver filtered water into a wash water storage tank for use in cleaning filters. Two vertical centrifugal pumps, each of a capacity of 1,700 gal. per minute, return the used wash water to the sedimentation basin.

Chemical mixing machinery is operated by electric motors. All pumps are driven by alternating-current motors, direct-connected, on a 550-volt, 3-phase, 60-cycle current.

Wash Water Tank.—A tank 29 ft. in diameter and 34 ft. high affords sufficient water to wash two filters in succession. It is arranged, however, in connection with pumps so that it automatically begins to receive water as soon as a wash begins.

Superstructure.—The superstructure is a two-story building 223 ft. long by 71 ft. deep with a central tower enclosing the wash water tank. The first story is concrete, the second story is faced with tapestry brick and synthetic stone trim, and the roof is concrete covered with a waterproof membrane. The interior is finished in a manner appropriate to its various uses. The superstructure houses the filters, administration offices, laboratory, chemical storage room, wash water tank, pumps and all other machinery and all other devices for the operation of the plant.

Special Treatment.—During the periods of high water in the streams from which the supply is taken it may at times be necessary to add a small amount of soda ash to the raw water as it flows through the 42-in. supply line at a point about 100 feet from the sedimentation basin. This added soda ash will make up any existing deficiency in alkalinity, and insure complete decomposition of the coagulant—sulphate of alumina.

Estimated First Cost.—In numerous respects this filtration plant differs from others elsewhere, and these facts have tended to increase its first cost. The natural attractiveness of the surroundings at the filter site demand something a little more than usually ornate in the way of architectural features. The abnormally large clear water basin made necessary in order to provide storage against a 50 per cent overdraft during the 16 hours the Fresh Pond Pumping Station is in regular service, furnishes a large item of additional cost over that to be met ordinarily. The aerator is another item, and the waste wash water receiving tank with piping connections and pumping equipment another. The contract price for the entire installation was $723,900, or $51,700 per million gallons rated capacity.

Edward W. Quinn is mayor of Cambridge and Timothy W. Good is superintendent of water-works and James J. Scully is president of the Water Board.

The general contract is being carried out by Coleman Bros., of Charlestown, Mass. The filter equipment is being installed by the Roberts Filter Manufacturing Co., Darby, Philadelphia, Pa. The designing and supervising engineers are the George A. Johnson Co., of New York City, for whom Fred S. Childs is the resident engineer.

British Concerned Over Foreign Competition

In England there appears to be the same situation regarding foreign competition in home-used engineering structures and equipment as was noted in *Engineering News-Record*, Aug. 11, 1921, p. 221, in the Staten Island pier cranes. The London correspondent of this journal writes:

Whether or not British firms and public bodies should accept tenders from abroad, even though they are considerably below the figures quoted by English manufacturers, is a question which is arousing much heated discussion among engineers. The latest example is the acceptance by the London County Council of a tender submitted by Brown and Boveri of Switzerland, for an 8,000 kw. turbo-generator set. The tender accepted is about £8,000 or 16 per cent lower than any British quotation. The British Engineers' Association has taken up the matter in vain with the Council and pointed out that Britain loses £25,000 by the work going abroad, £15,000 to £18,000 in direct wages to engineering trades, and probably another £10,000 in wages spent on raw materials. Thus, the British worker has lost the work, the foreign manufacturer gets a fine advertisement, and if he chooses to use German material he can make a big profit; the only benefit accruing to the British manufacturer will be the prospects of a higher rate of contribution to the unemployment funds.

The British Engineers' Association maintains that the London County Council makes it purchases with public funds for the purpose of rendering public services, and if the purchases be made in Britain the money expended remains there. In the case of an order for a turbo generator, at least 80 per cent of the purchase price would be distributed among the British workers in the form of wages and salaries. Owing to increased wage rates, reduced working hours, restricted output and other causes beyond the power of the employer to compensate by his own ability and enterprise, the costs of production in England have reached a point at which the country's power to compete in the export markets of the world is gravely impaired. Unless the engineering industry can have a fair chance of securing a very large share of the home market as a stabilizer, production on an economical scale, of the required variety of products, will be seriously restricted, now enterprise will be discouraged and a high rate of mortality may be expected among the smaller works started since the war began, whereby unemployment would be increased, and large capital investments sterilized.

LETTERS TO THE EDITOR

If you have ideas that would interest engineers and contractors we shall be glad to give them space here. We urge, however, that you be brief so that a wide range of subjects may be covered in the available space.—The Editor.

Poor Design Cause of All Structural Failures

Sir:—In your issue of Aug. 18, p. 271, there is a report of the collapse of a reinforced-concrete ceiling in the Marlborough-Blenheim Hotel at Atlantic City. This article and your editorial point to the rusting of steel as the cause of this failure, and you make the statement that this is the first example of the failure of a reinforced-concrete structure after the same was put in service.

I should like to point that in *Engineering News*, April 23, 1908 there is an account of a reinforced-concrete girder bridge that collapsed in the night with no load upon it, *two years after it was built*. In *Engineering News*, Dec. 27, 1906, there is an account of a similar bridge that collapsed under a traction engine after it was in service for some time. Both of these bridges had short shear members.

There have been other failures and partial failures that did not happen during construction. I know of three large buildings that had to be "unloaded" years after they were built. None of these cases are published. Doubtless other engineers could add to the list. Corrosion had nothing whatever to do with these three failures. It was original weakness in design.

I have frequently advanced the proposition that practically all structural collapses are due to poor design, including about all of the many reinforced-concrete failures during construction or later. This ceiling is no exception. The unit stress on the little wires was 100,000 lb. per square inch. Why look for corrosion or for any other reason whatever for the collapse? The marvel is that it did not collapse many years ago, and the explanation is that the long-suffering concrete was taking the tension. Concrete in a beam or slab of normal reinforcement will be subject to five or six times as much tension as the steel so long as it is not cracked. In this particular design the concrete tension would be probably ten or twenty times that of the steel.

Pittsburgh, Pa., Aug. 27. EDWARD GODFREY.

Timber Truss Roofs of Navy Hangars

Sir—I was much interested in the article on the curved-chord timber roof truss on page 246 of the Aug. 11 issue. This type of truss is not new. I have no doubt that Mr. Summerbell will be able to secure a patent, knowing the patent office as I do, but I doubt very much his ability to maintain any infringement suit that he might enter after he has the patent.

Early in 1917, while I was working as a designer in the Navy Department, the question of the standard type of airplane hangar to be built abroad arose. The steel market was swamped, and studies were made for timber hangars. Ellis P. Abbott, under whom I was working, submitted to me an article from some engineering magazine describing and showing drawings of a curved-chord timber truss similar to the one in the current article. These had been used in Chicago for roofs of garages. The design was modified and changed to save material and to meet the required conditions. The principal change that we made in the design as shown by the old magazine article, was rearrangement of the web members. These were uniformly spaced in the original Chicago garage trusses, and spaced quite closely. As shipping space was at a premium we made a more thorough analysis, and were able to leave out many web members near the center, so that the spacing was closer at the ends, a modification which I notice is embodied in the design with which the present article is concerned.

The hangars were 100 ft. wide in the clear and 40 ft. high. No knee braces were permissible, and it was necessary to use tie rods on the outside. The trusses were 11 ft. deep at the center. The upper chord was made up of ten 2 x 4's, five on each side, curved to proper shape. The lower chord was made up of six 2 x 6's, three on each side, and the web members were 2 x 6. Each truss was made in two halves, the web members being opposite hand. One half was then placed over the other and the chords bolted together. The web members were properly nailed together.

The great advantage of this type of truss for the purpose intended was that it required no framing to erect. All shipment was made in stock sizes and the construction was a case of sawing, bolting and nailing only. As the erection of the hangars was done by inexperienced men, the elimination of framing and the numerous complicated details of workmanship which are necessary to make a good framed timber truss, was considered a great advantage.

Two of these hangars were built in a cornfield near Washington as an experiment, proved very successful, and were put to immediate use. I do not believe that I am violating any naval secrets at the present time to state that these two hangars were erected in 15 days. A large number of them was built abroad. I have seen a number of these trusses in use at various times and places during the past few years. The new Chevrolet Motor building on Gilbert Avenue, Cincinnati, a building several hundred feet long, is the latest that I have seen. The truss is a good one, and ought to have a big field of use, but it is not a new thing.

Cincinnati, Aug. 13. EDGAR DOW GILMAN.

Unwashed and Ungraded River Gravel Makes Good Concrete

Sir—In developing a new coal mine for the Spruce River Coal Co. at Jeffrey, W. Va., it was necessary to build several miles of standard-gage railroad which crossed two streams requiring bridges. These bridges were of the deck type, with wooden stringers resting on concrete abutments and piers, calling for some 400 cu.yd. of materials.

Although close to the railroad the cost of shipping in sand and gravel for this work was rather expensive. After some investigation it was decided to use gravel and sand from the creek bed at the site of the work.

This portion of West Virginia is quite mountainous and considerable sandstone abounds. The streams are typical mountain streams, almost dry in continued hot weather but rising to rushing torrents after a few hours of heavy rain. Many gravel bars and riffles have been formed by these streams and the materials are excellent if they were cleaned and graded. However considerable loam is mixed with the gravel and in places yellow clay. The stones are of all sizes from ones larger than one's hand on down.

This gravel was excavated and hauled to the site of the work and dumped in piles. When wet it seemed very dirty but upon drying out had a light grey color and the sand seemed sharp although mixed with loam. This material was mixed in a gasoline mixer and proportioned three bags of cement to one yard of concrete. It was poured rather wet and openings were left at intervals in the forms to allow the scum to drain off.

The first few days after the removal of the forms the concrete did not seem to harden as rapidly as it should. The loam seemed to have worked to the face of the forms and made the concrete look dirty and ragged. It has now been completed about six months and is as hard as stone. The dirty, ragged appearance has entirely disappeared and the color is good.

In connection with our new tipple construction we have constructed two retaining walls, one foundation wall and about 75 or 80 piers of the same material. These all appear to be excellent and are of good color and very hard. In the retaining walls we used a great deal of loose rock as well, throwing it into the forms as the concrete was poured. The rocks were sandstone of all shapes and sizes from the size of a footwall on down. We had occasion to drill several holes in one of these walls several days after it was completed and we found it to be very hard, but tough rather than brittle. J. S. KENNEDY.

Engineer, Spruce River Coal Co.

Ramage, W. Va., Aug. 2.

Shear Resistance in Wooden Beams

Sir—The letter of A. M. Van Auken in your issue of July 21, 1921, p. 119, on the disparity between theory and practice in the design of timber beams for longitudinal shear calls attention to a condition which, though not new, is frequently neglected. Recommended working stresses for timbers are based on tests conducted in accordance with laboratory practice. For flexural tests, the customary practice is to use third-point loading, which means the concentration is placed a distance out from the support equal to four or more times the depth of the beam. On this basis, in the case of southern pine, the computed horizontal shear at failure in tests will average about 1,000 lb. per sq.in. for small clear specimens and approximately 400 lb. per sq.in. for structural-size specimens. Using a factor of 8 on the small specimen results, the value specified in Mr. Van Auken's letter for working stress in longitudinal shear, 125 lb. per sq.in. is obtained. If this stress is to be employed in practice for concentrated loads, it should be under the same conditions of loading as obtained in the tests, that is, under conditions of maximum bending and deflection, and not maximum end-shear conditions.

Under laboratory test conditions, both the transverse and horizontal unit shear have a constant value $\frac{3}{4}W/bd$ from the point of support to the center of the concentration, as shown by the shaded diagram in Fig. 1. In practice, for uniform loads or a series of concentrations the unit shear will decrease from a maximum at the end of the span toward the center. An increase in unit longitudinal shear for design should be permitted to compensate for this condition.

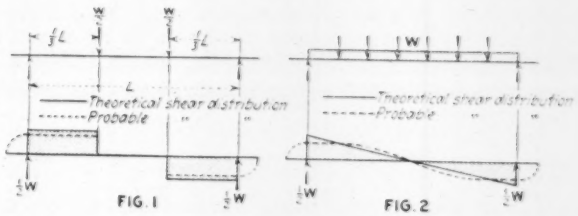
Again, the effects of direct transverse compression at the end bearing and under concentrations when located near the support are also neglected in design. The frictional resistance of wood on wood along the neutral axis under such normal pressures can be evaluated, and should be compensated for in the allowable longitudinal shearing stress. A third factor which increases resistance to longitudinal shearing is the overhang of the beam at the support. The effect of this is indicated in Fig. 2, on the shear diagram for uniform loads.

In the case of a stringer continuous for two spans over a central support, the tendency to longitudinal shear will be still further decreased. Also, by the common theory of flexure applied to a homogeneous material like timber the neutral axis is assumed at the center of the cross-section. As a matter of fact, both the strength values and the moduli of elasticity for timber in tension and compression are different, with the result that the neutral axis probably adjusts itself as in a reinforced-concrete beam. The resulting distribution of shear is probably such as to give much higher longitudinal shear on the compression side of the beam, particularly under concentrations.

The logical method of designing for longitudinal shear would be to establish permissible working stresses based on the distance of the concentration from the end support when placed for maximum end-shear conditions. The resistance to horizontal shear increases rapidly as the load is moved toward the point of support. L. R. Manville and C. R. Hill, in *Engineering News-Record* for July 10, 1919 p. 69, describe flexural tests of 31 longleaf yellow pine beams, in which a special study was made of the effect of position of the applied load on the resulting horizontal shearing stresses. The authors conclude, among other things, that:

1. No horizontal shear failure may be expected with the concentration placed within one beam-depth of the end support;

2. A concentrated load placed three beam-depths from the end support is more apt to cause failure than if placed out a distance of one or two depths, although the computed horizontal shear is less;



SHEAR DISTRIBUTION ALONG A BEAM

3. Beams with a ratio of length to depth of 12 will develop a critical stress in horizontal shear simultaneously with a critical stress in bending, while when the ratio of span to depth is less than 12, horizontal shear failures are apt to predominate;

4. With timber selected under the density rule of the U. S. Forest Service, horizontal shearing stresses 50% in excess of the ordinary design unit stresses may be used when the shear is computed by the usual method with concentrations within 1½ beam-depths of the end support.

In those tests, on 4 x 10-in. southern pine beams on 7½-ft. clear span, horizontal shear failures occurred at computed shears of 580 lb. per sq.in. with the concentration 3 beam-depths from the support, and at computed shears of 920 lb. per sq.in. with the concentration at 1½ beam-depths from the support. Where failure occurred by rupture of extreme fiber, 7,000 lb. per sq.in. was developed as an average modulus of rupture. Tests of the Forest Products Laboratory on 6 x 12-in. dense southern pine selected in accordance with the select structural grade rules of the Southern Pine Association, on 15-ft. span, developed a modulus of rupture of 8,000 lb. per sq.in., with an average computed horizontal shear of 400 lb. per sq.in., the test loads being applied at the third-points of the span (see table herewith). It is manifestly unjust to the timber to limit working stresses to values as low as those generally recommended, which are based on test interpretations not consistent with practice, particularly when careful inspection of the timber and application of strict grading rules are introduced.

The practice of designing timber stringers with a horizontal shearing stress of 200 to 225 lb. per sq.in. appears warranted when the stress is computed for maximum end-shear conditions with concentrations spaced within 1½ to 2 beam-depths of the end support, and successful practice would appear to justify these values.

GEO. E. STREHAN,
Consulting Engineer.

New York City, Aug. 3.

TESTS OF FOREST PRODUCTS LABORATORY ON SELECT STRUCTURAL GRADE SOUTHERN PINE TIMBERS

Timbers 6 x 12 in. x 16 ft.; test span 15 ft.

Piece No.	Rings per Inch	Summer Wood, Per Cent	Specific Gravity*	Moisture Content, Per Cent	Modulus of Rupture, Lb.Sq.In.	Fibre Stress Elastic Limit, Lb.Sq.In.	Modulus of Elasticity, Lb.Sq.In.	Computed Hor. Shear, Lb.Sq.In.	Defects and Failure
9	23	38	0 57	17 6	9,850	7,110	1,950,000	483	Light season checks, horizontal shear failure.
2	19	35	0 58	15 8	7,540	4,900	1,977,000	366	Diagonal Grain Vol. 1, Irregular Grain Vol. 3, Tension failure
8	20	36	0 55	17 1	6,580	6,580	1,702,000	324	Cup shake at top, tension failure.
9	12	43	0 55	16 0	8,840	5,780	1,940,000	444	Light season checks, tension failure.
15	9	42	0 60	15 5	8,200	5,780	2,181,000	412	Radial shakes both ends, slight checking, horizontal shear failure.
19	10	39	0 56	15 5	8,190	4,770	1,853,000	411	Small knots in Vols. 1 and 2, tension failure.
17	12	52	0 73	16 6	7,760	5,910	2,498,000	386	Radial shake, both ends, small cup shake at butt horizontal shear failure.
13	12	37	0 70	16 2	6,700	5,160	2,029,000	343	Light shakes both ends, considerable checks, horizontal shear failure.
Aver.	14 6	40	0 61	16 3	7,960	5,750	2,016,000	396	

* Oven-dry weight and volume.

HINTS FOR THE CONTRACTOR

Belt Conveyor Used in Placing Concrete

By John Stearns
Construction Engineer, J. G. White Engineering Corporation, New York City

FOUNDATION work at the Tuckerton station of the Radio Corporation of America presented a problem of unusual interest, both in distributing material and in mixing and placing concrete. In the solution of this problem the use of a belt conveyor for elevating concrete to the mast foundation forms aided materially. The station is situated on the New Jersey Meadows about six miles from Tuckerton where the soil is of such a character as to be incapable of sustaining any but the lightest kind of construction equipment. The station was built by the German government prior to the entry of the United States into the war and later acquired by the Radio Corporation of America, who desired to increase the antenna capacity by the erection of six steel masts each 350 ft. high, and by the installation of the latest design of radio equipment.

In order to avoid the possibility of ice piling up against the guys and masts the concrete foundations were extended from 8 to 10 ft. above the elevation of the meadows. One mast and four anchors required approximately 250 cu.yd. of concrete, which was placed in about five equal pours. One-bag mixers with extra wide-tired wheels were particularly adaptable for this work. These were operated in conjunction with 30-ft. portable belt conveyors, as shown in the attached photographs, which raised the concrete to an elevation that would permit of its distribution into the forms by chutes. The distance the concrete was elevated was 15 ft. and the length of the conveyor was 28 ft., making the angle of inclination of the conveyor around 33 deg.

Concrete was dumped from the mixer into a wooden hopper having an opening directly over the conveyor (the belt traveling just under the hopper opening), picked up the batch and elevated it to the chute. On top of the chute and underneath the returning belt was placed a wiper of rope or belting so that all of the concrete would be taken from the belt. On the chute also was placed a baffle board which returned any sand that might have separated from the batch on its trip up the belt to the chute, to become re-consolidated with the batch. There was a tendency of the sand to separate due to the fact that it left the conveyor with a greater velocity than the rest of the batch. The concrete thus poured was wet enough to run freely.

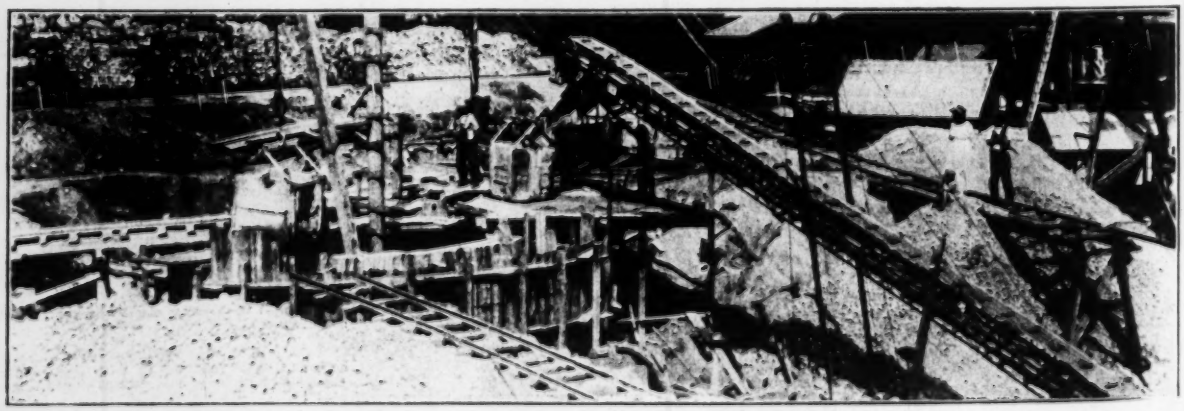
The conveyor equipment was also used to pour the foundation for the second alternator. The set-up was made outside the building and the conveyor, passing through the power-house window, dumped the batch into the chutes and thence to the forms. By this means the concrete was mixed in the open and distributed without interfering with the operation of the station.

Wireless Tower 200 Ft. High Moved

By A. T. Colwell
Lieutenant, Corps of Engineers, U. S. A., Fort Sam Houston, Tex.

ONE of the wireless towers at Ft. Sam Houston, Texas, was recently moved 250 ft. on street-car trucks running on specially placed street-car track. The towers are 200 ft. high, 26 ft. square at the bottom, tapering to 8 ft. square at the top, and the four principal uprights taper from an 8-in. angle at the bottom to a 3-in. angle at the top. Their weight is approximately 40 tons each. The original sending power was tripled, making it necessary to move the towers so as to utilize all the induction.

In moving the tower a street car was removed from its trucks, and four trucks were used for the job. Two 12 in. x 12-in. pieces 15 ft. long were laid on the axles, and held in place by 2-in. angle irons underneath. The four concrete foundations for the new site were laid, and track was laid from the old site to the new. Eight screw jacks were used to raise the tower, and the track was laid over the old foundation, the trucks run in and the tower lowered upon them. Two men working a 5-ton chain block moved the tower up a 1 per cent grade to the new site. The trucks were not anchored to the track, as the top of the tower was at no time more than 4 ft. off, and the center of gravity fell well within the base. The tower had two 12 in. x 12-in. timbers bolted to the bottom of each leg, and when it was in position over the new site, it was jacked up by means of these members, the trucks and track removed, and a grillage built up. The tower was then lowered, the grillage being removed 6 in. ahead as it came down.



BELT CONVEYOR ELEVATING CONCRETE AT 33-DEG. ANGLE

NEWS OF THE WEEK

New York, September 8, 1921

Strauss Sues Seattle for Infringing Bascule Bridge Patent

Alleging that the city of Seattle infringed on its patent rights in the construction of three bascule bridges across the Lake Washington ship canal and Lake Union, the Strauss Bascule Bridge Co. an Illinois corporation, has filed suit in the federal court to recover damages of $353,140.85 and interest. The finance committee of the city council had previously rejected a claim presented for that amount. The company, which is represented locally by Robinson, Murphy & Murphine, attorneys, asked for a permanent injunction and for a provisional injunction enjoining officials from proceeding with any bascule bridge work now contemplated.

The three bridges involved are the 15th Ave. Northwest, the Fremont Ave. and the Tenth Ave. Northeast structures. For each of these the company claims damages equal to three times 10 per cent of the cost. The complaint filed recites that similar suit was brought against the city of Chicago for infringements in the construction of ten bridges of the bascule type, resulting in a decision by the master in chancery of the U. S. District Court of Illinois favoring the company. The decision was appealed to the U. S. District Court, which sustained the order of the lower magistrate and was taken to the U. S. Court of Appeals, where the company's suit for damages was again granted. In this case the company was awarded damages in the sum of $349,500, the complaint alleges.

Resolution for Illinois-Indiana Harbor Commission

A resolution has been introduced in Congress authorizing the appointment of the Interstate Harbor Commission of Illinois and Indiana, following acts of the Illinois and Indiana legislatures to investigate and report upon the feasibility of a public interstate harbor. The harbor would be "at and near Wolf Lake and Lake Michigan, lying partly in the cities of Hammond and Whiting, Ind., and partly in the city of Chicago."

New Members of International Road Congress

At its last meeting the Permanent Commission of the International Association of Road Congresses announced that the following governments have taken membership: Servia, Croatia, Slavonia and Czecho-Slovakia. During the last year 116 new private members have been admitted, forty of them as life members, while fifty-nine new corporations have also joined.

Free Port Zone Advocated by Senate Committee

Establishment of foreign trade zones in ports of the United States is recommended in a report of the committee on commerce of the United States Senate. A bill is reported which will make such a zone possible.

New England Water-Works Men Announce Convention Program

The New England Water Works Association announces the following program of technical papers and reports for its 40th annual convention to be held at the Stratfield Hotel, Bridgeport, Conn., Sept. 13-16:

Sept. 13, 2 p.m.—"The Water Works of the Bridgeport Hydraulic Co.," by S. P. Senior.

Sept. 14, 8:30 a.m.—Report of committee on standard specifications for water meters, W. W. Brush, chairman; "Manganese Bronze for Valve Stems," by W. R. Conrad; "Monel Metal," by H. S. Arnold.

Sept. 14, 2 p.m.—"Economy of High Initial Cost and Extreme Care in Service Pipe Installation," by Reeves J. Newson; Disappearance of Coating from Cast-Iron Pipe While Stored in Yard," by Samuel E. Killam; "Control of Water Waste by House-to-House Inspection," by Gordon Z. Smith.

Sept. 14, 8 p.m.—"Reinforced Concrete Pipe," by W. G. Chace; "Selection of Pipe for Water Works," by J. W. Ledoux; "Chlorination of New England Water Supplies," by W. J. Orchard.

Sept. 15, 9 a.m.—"Electrolytic Generation of Chlorine at Its Point of Application," by C. W. Marsh; "Typhoid Fever Epidemic at Salem, Ohio," by W. H. Dittoe; "Significance of 'Hydrogen-Ion Concentration' in Water Purification," by Harrison P. Eddy.

Sept. 15, 2 p.m.—"Can High-Value Watershed Lands Be Put to Profitable Use?" by S. P. Senior; "Economies of the Several Lines of Defense in the Protection of Water Supplies," by Allen Hazen.

Sept. 15, 8 p.m.—"Appraisal of Quality of Water Supplies in Massachusetts," by Prof. George C. Whipple; discussion of water works accounting.

Sept. 16, 9 a.m.—"Pollution of Streams Affecting Industrial Uses," by J. Frederick Jackson; "Repairs to Standpipe at Bath, Maine," by Clarence E. Carter.

The convention will end with a picnic and shore dinner at "The Farms," arranged for by the Water Works Manufacturers Association.

Samuel P. Senior, chief engineer of the Bridgeport Hydraulic Co., is chairman of the local committee on arrangements.

Object to Hudson River Pontoon Bridge

Shipping Men Condemn Project as Menace to Navigation at Hearing Before Army Board

In a hearing before a board of army engineers in New York Aug. 31 on the proposed pontoon bridge across the Hudson River at Yonkers, river-steamer and canal-barge shipping men vehemently opposed the bridge project. Favorable arguments having first been presented by the company and by citizens of southern New York and northern New Jersey west of the Hudson, the opposition was represented by F. Coy Kendall, of a barge-towing company, Capt. Keller, in charge of one of the large Hudson River passenger steamers, Capt. Davis, representing the Masters, Mates and Pilots' Association, and a number of other river captains and officials of freight and passenger steamer companies. Prof. William H. Burr expressed views similar to those of the shipping men.

As stated by Gustav Lindenthal, engineer of the company, and George A. Post, president, the latest plans for the bridge contemplate providing a fixed span 270 ft. clear opening, with 45-ft. vertical clearance, to accommodate barges and low vessels, and a draw span for large steamers and masted vessels. However, the shipping men claimed that these proposed openings were impossible of navigation against unfavorable wind and tide conditions, as instanced by the fact that tows have hard work in passing under the Poughkeepsie bridge, with openings of about 500 ft. and the weaker tidal current.

Capt. Keller claimed that if a river steamer encountered a tow of barges in the draw it would mean an accident. Capt. Davis said that the bridge would be destroyed by ice, and that the plan to keep the ice broken up by towboats could not be carried out. Others spoke to the same effect. Prof. Burr stated various objections, among them that the lift span would be a menace to boats below, in wind and current, and expressed the view that the proposed structure is not entitled to confidence structurally, and should not be built either across the Hudson or elsewhere.

$15,000 for Sealing Reservoir

The city of Seattle will continue its efforts to seal the Cedar River basin, back of the city's masonry dam, as evidenced by the introduction of a bill in the council authorizing the continuation of the work and making an appropriation of $15,000 for the purpose. The bill was referred to the finance and city utilities committees.

Federal Permits for Water Powers in Idaho and Virginia

Announcement has been made by the Federal Power Commission that a preliminary permit has been issued to the Utah Power and Light Co. for extensive power development on the Bear River in southeastern Idaho. The projected works will impound water for irrigation as well as power. The project will complete the utilization of the river for power purposes at all practicable points from Bear Lake and the mountains of Idaho and Utah to Great Salt Lake and will add 21,500 hp. to the generating capacity of the company's system, now capable of developing about 165,000 hp. The transmission will be 134 miles to Salt Lake City.

Developments under the new scheme will be in four sites on the upper part of the river, two of which, with heads of 75 and 85 ft. each, will have each a primary capacity of about 6,500 hp. The two lower sites will develop about 9,800 hp. Three plants already exist in the upper district and one in the lower so that the river will, when the new scheme is complete, have eight power plants. The company has 33 months within which to make a study of the character of the foundation for the projected dam and for the amount of water available for power purposes at each site.

The Roanoke River Development Co., of Richmond, Va., has also been granted a preliminary federal permit for a power project to be located at Buggs Island in the Roanoke River near Clarksville, Va. Two years are allotted to investigate the development which is planned to consist of a dam 60 ft. high across the river with a power house across the river with a power house located at the dam, by which means 10,000 primary horsepower can be developed as well as a secondary development aggregating perhaps 6,000 hp. The primary power will be used for general public utility and industrial purposes and the secondary power for chemical plants in Richmond.

Improved Rail Income Laid to Deferred Expenses

That the improvement in railroad operating income has been brought about in large part by deferring expenditures for maintenance and by drastic cuts in forces is indicated in an analysis of operations for the first six months of the year, made public by the Bureau of Railway Economics. Of the decrease in total operating expenses as in comparison with 1920, 45 per cent, or $44,748,799, occurred in June from reduced transportation expenses, and 55 per cent, or $54,256,689, from deferring expenditures for maintenance of way and equipment. While reduction in transportation costs naturally follows falling traffic, it is pointed out that reduction in maintenance is merely a postponement of expenditures that will have to be made up at a later date.

Confident of Road Bill's Passage

(Washington Correspondence)

It is the consensus of opinion in Washington that the highway bill will become a law before Nov. 1. It is a matter of disappointment to Senator Townsend that an agreement was not reached prior to the Congressional recess. The differences between the bill as it passed the Senate and the bill passed by the House were not many. There was a feeling on the House side, however, that they would occasion more discussion than the very limited time, prior to the recess, would have permitted. As a result the differences will have to be harmonized after Congress reconvenes.

There is no disputing that several influential members of each House of Congress are not enthusiastic over the project of appropriating $75,000,000 at this time. They are in a position to delay the time when this money will be made available. They may recognize an overwhelming public demand for the highway money, however, and forego dilitory tactics. On the other hand it is not to be supposed that they will abet any effort to make the appropriation available with unprecedented promptness. As a result there is some uncertainty as to just when the new federal-aid appropriation will be available for distribution, but no doubt is expressed in any quarter as to the final passage of the bill.

War Department Permits Chicago to Reclaim Lake Front

A permit has been issued by the Secretary of War granting Chicago the right to extend the shore line of Grant Park 300 ft. east into Lake Michigan. The permit makes possible the construction of a boulevard that will run directly north from the recently opened Field Museum and south to Jackson Park, using a $20,000,000 bond issue already voted upon favorably to carry out the plans of the Chicago Plan Commission. These plans have been worked out in conjunction with the War Department represented by Col. W. V. Judson, corps of engineers, the South Park Board, the City of Chicago and the Illinois Central R. R. The work will be carried out under the direction of the South Park Commission which is now preparing construction plans for breakwaters, filling and structures. A 200x600-ft. pier and slip for the headquarters of the U. S. Naval Reserves is included.

St. Paul Union Station Work To Be Shut Down

It has been announced that the St. Paul Union Depot Co. will discontinue work on the new station at St. Paul, Minn., at the end of this season's work because of the present financial stringency, especially in the railway field. This season's work will permit six new elevated tracks to be used and will enlarge the conveniences to the public somewhat. The waiting room has not been built and the business lobby will continue to be used for that purpose.

Niagara River Bridge Project Again Active

A bill for a Congressional charter for the construction of a Niagara River crossing at Buffalo has been introduced in the House of Representatives. It authorizes twenty-five named persons, among whom are J. W. Cowper, W. A. Eckert and E. P. Lupfer, to construct and operate a bridge across the Niagara River or, with the consent of the Secretary of War, a tunnel. Construction must be begun within two years and completed within five years from approval of the act. A joint commission of five men each from the United States and Canada is at work on the project, under prior Congressional authorization.

Motion Picture Shows New York Freight Terminal Movements

A motion picture illustrating the movement of freight in the Port of New York was presented in New York City recently by the recently constituted Port of New York Authority. The film was prepared under the direction of the old New York, New Jersey Port and Harbor Development Commission and illustrates the recommended deep-tunnel, automatic-electric railroad for the distribution of Manhattan freight.

The film is now presented by the Port Authority for public consideration. It is introduced by maps and airplane views of the port district, followed by motion pictures of ocean steamship, railroad pier operation and the railroad yards. The recommended belt line system is shown graphically. The picture also includes a comparison of the journey, and its cost, of "Mr. Potato" through the New York terminal by present methods and by the proposed automatic-electric system.

Low Bids for Sixteenth St. Bridge at Pittsburgh

Bids received by Allegheny County Aug. 27 on substructure and superstructure of the proposed Sixteenth St. bridge over the Allegheny River at Pittsburgh, designed by Warren & Wetmore, architects, with H. G. Balcom as engineer, proved unexpectedly low and showed active competition. On the substructure, for type of construction with concrete core and stone veneer, the bids were: Vang Construction Co., $457,220; Dravo Contracting Co., $497,292; Foundation Co., $527,975. The foregoing amounts do not cover the concrete floor filling and paving, which is to be let subsequently; its estimated cost is $110,000. Bids on the construction of the steel superstructure (about 5,200 tons) were: Fort Pitt Bridge Works, $541,822; McClintic-Marshall Co., $565,570; American Bridge Co., $649,874; Independent Bridge Co., $822,400. On the electrical equipment, the City Electric Co. was low bidder, at $5,755.04. On Sept. 1 the county commissioners awarded the substructure contract to the Vang Construction Co. and the superstructure contract to the Fort Pitt Bridge Works.

Concrete Arches Over Scioto Opened to Traffic

Two new concrete arch bridges, the Broad St. and Town St. bridges, across the Scioto River at Columbus, O., replacing bridges destroyed in the great 1913 flood, have been opened to traffic, following the opening of the Mound St. bridge on July 2, as noted in our issue of July 28, p. 166. They are now open to foot and street-car traffic and will be open to vehicle traffic as soon as the paving now in progress is completed. They were built by Franklin County, at a cost of about $600,000 each.

Tentative R.R. Valuations

Additional tentative valuation reports, including the Mobile & Ohio and Florida East Coast properties, have been handed down by the Interstate Commerce Commission. The reports are of June 30, 1916. Final value of the Mobile & Ohio is given at $43,279,997, as against an outstanding capitalization of $37,807,800. Final value, cost of reproduction and outstanding capitalization of properties reported on are given in the accompanying table.

Name of Road	Final Value	Cost of Reproduction New	Cost of Reproduction Less Depreciation	Outstanding Capitalization
Marion & Rye Valley Railway Co.	$317,177	$408,800	$317,731	$274,500 00
Mobile & Ohio Railroad Co.	43,279,997	46,784,157	35,231,583	37,807,800 00
Warrior River Southern Ry. Co.	770,000	840,605	715,939	1,081,171 53
Kentwood & Eastern Ry. Co.	340,000	361,211	276,408	100,000 00
Florida East Coast Ry. Co.	46,931,947	43,707,785	38,736,375	47,300 00
Atlantic & East Coast Terminal Co.	1,200,000	296,230	265,507	603,502 87
Kankakee & Seneca Railroad Co.	800,000	975,359	720,407	852,399 58
Muncie Belt Railway Co.	62,654	78,198	49,548	75,000 00
Clarendon & Pittsford Railroad Co.	490,000	594,588	448,924	270,000 00
Roscoe, Snyder & Pacific Ry. Co.	558,394	619,691	463,362	307,511 46
Portland Terminal Company	7,022,530	6,001,170	4,382,255	5,752,000 00
Jonesboro, Lake City & Eastern R. R. Co.	1,117,328	1,264,884	968,543	1,294,934 83
Chicago, Wabash Valley R. R. Co.	455,500	439,028	376,339	1,012,853 05
Milledgeville Railway Co.	70,551	88,659	64,580	125,481 95
Monroe Railroad Co.	119,000	131,040	94,963	237,207 31
Sugar Land Ry. Co.	484,983	525,552	407,645	509,880 00
Moshassuck Valley R. R. Co.	160,404	128,451	94,414	250,000 00
Bangor & Aroostook R. R. Co.	21,500,000	29,352,360	22,776,234	24,249,600 00
Northern Maine Seaport R. R. Co.	3,850,000	4,655,574	3,639,413	5,140,000 00
Van Buren Bridge Co.	77,500	77,869	76,257	500,000 00

Create Safety Section of A.R.A.

Following the meeting in Chicago between R. H. Aishton, president, American Railroad Association, and twenty-five safety representatives of leading railroads, a safety section of the A.R.A. has been created by the board of directors, carrying out the recommendation of its chairman, Daniel Willard, president of the Baltimore & Ohio R.R. The general object of the safety section is co-ordination of safety methods and development of unified plans for effecting safety measures. Permanent officers of the section will be elected at the next meeting in Boston, Sept. 26, 1921. In the meantime the following temporary officers have been chosen: Chairman, E. M. Switzer, Chicago, Burlington & Quincy R.R.; first vice-chairman, John T. Broderick, superintendent of safety, Baltimore & Ohio R.R.; second vice-chairman, Isaiah Hale, Sante Fe R.R. A board of direction and committees to formulate a plan for preliminary work were also appointed at the meeting.

1921 a Big Highway Year

(Washington Correspondence)

Judging from the information now before him, Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads, states that 1921 will be the banner year in highway construction. The year 1920 saw the execution of several times more highway work than ever had been done in the United States in a similar period of time. Enough data now are available to indicate that the 1921 record will exceed that of 1920 by a considerable margin.

An idea of how rapidly highway work is progressing in some states may be gained from the 1921 accomplishments of the Pennsylvania highway authorities. On Sept. 1 they were well beyond the 400-mile margin of paved road construction. This is more than 100 miles in excess of all paved road construction done in Pennsylvania during 1920.

The assurance that the highway bill will become a law shortly after the reconvening of Congress on Sept. 21 will make it possible for highway construction to proceed during the calendar year of 1922 at an unprecedented rate. The certainty that this legislation will be enacted already has stimulated construction in many states. As soon as the bill becomes a law, Mr. MacDonald states, it will release a large number of projects, particularly in the West. He also calls attention to the fact that these projects are in an area in which unemployment is acute.

Reservoir Safe, Court Rules

In a recent decision in the Supreme Court, contrary to the decision of the Superior Court, the injunction restraining the Seattle City Council of Seattle, Wash., from erecting a new and enlarged reservoir in Volunteer Park, is dissolved. The injunction was granted in the Superior Court, upon appeal of Pierre F. Ferry and other citizens owning valuable property in the vicinity of Volunteer Park. The Supreme Court has ruled that fears of damage or disaster by residents of the Volunteer Park section in Seattle lack insufficient basis as against the engineering showing of safety. The injunction granted is set aside and the action dismissed.

British Engineer Studies American Roads

A. Dryland, County Engineer of Middlesex, a Pioneer in the Tarring of Highway Surfaces

A. Dryland, county engineer of Middlesex, England, past-president of the British County Surveyors Society and pioneer in the field of road tarring, is in the United States on a trip of inspection of American roadbuilding practice. His professional experience covers a period of forty years as county engineer and surveyor in half a dozen of the principal districts in England.

He began his engineering work in 1880 by being articled to A. W. Conquest, borough engineer of Folkestone, who had received his training on the main drainage works and pavements of London under Sir Joseph Bazelgette. At that time municipal work was just developing into a field of importance and Mr. Dryland's early duties involved road construction and maintenance, seaside defenses, parks, and drainage.

First to Tar Roads

After three years in a subordinate capacity, he was appointed borough engineer of Deal, then a town of 9,000 population on the east coast. Here he served for seven years, until 1890, and for the fist time in that part of England employed tar for treating roads. This was before the advent of heavy motor traffic and curiously enough the tar application was made not to reduce dust or to improve the wearing qualities of the highway surface, but to reduce the noise of metal-tired vehicles passing the Town Hall of Deal, about which complaint had been made. The treatment proved so successful, however, that it was soon extended to other routes of the borough. In addition to his road work at Deal, Mr. Dryland was called upon to build many sea defense works, and by timely construction he was able to save the greater part of an old castle, built by Henry VIII, which the sea had undermined.

When county councils were first being established in England in 1890, Mr. Dryland was called to Kent and appointed county engineer of that district. Roadbuilding then was at a low ebb, but through his efforts new routes were constructed, old ones put in a satisfactory state of maintenance, and many bridges built and repaired. After two years' service in Kent he became county engineer and surveyor of Herefordshire, where he took charge of about 500 miles of roads and 400 bridges. On this work an extensive bridge strengthening program was undertaken due to the development of traction engines weighing 18 tons and

hauling three trailers, a train of this sort often reaching a gross weight of 50 tons. Mr. Dryland's administration was marked by an extensive program of surface treatment of roads with tar.

THE "APOSTLE OF SIDE SUPPORT"

In 1906 he was called to take charge of a larger county, Wiltshire, where he served to years. Here he reorganized the administrtion of 800 miles of main roads and introduced on an extensive scale methods of surface tarring and penetration work. In 1908 he became surveyor of Surrey County, to the south of London. Surrey is the playground of the metropolis and consequently handles a huge volume of motor traffic. Mr. Dryland devoted a great deal of his time to an alleviation of the dust problem by treating road surfaces with tar, and this form of protection was extended to every main road in his county. It was here that the introduction of heavy motor trucks began pushing the tartreated surfaces and road bases toward the sides of the road, leading Mr. Dryland to insist upon the use of concrete curbs from 9 to 12 in. in depth to hold the foundations in place. His experience has made him a consistent advocate of this policy and he has become known among his associates as the "apostle of side support."

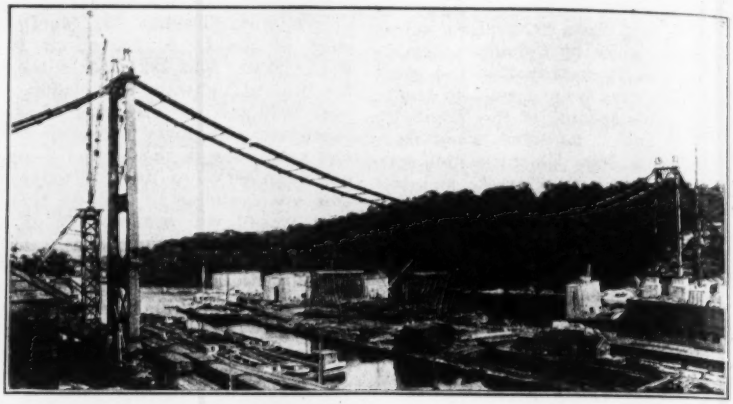
He resigned his position in Surrey in 1920 to become county engineer of Middlesex, a territory surrounding the London County Council area on the north side. The establisment of scores of military training camps in this district during the war, particularly at Aldershot, placed a heavy burden upon the county roadbuilding and maintenance forces. After the war Mr. Dryland's chief problem was on the arterial road system for which a large construction program had been prepared as a means of giving employment to ex-soldiers. Most of these arterial roads are 100 ft. wide, consisting of two 24-ft. trafficways with a space between for tramways and heavy trucking. At the present time only one of the 24-ft. roadways is being developed.

Mr. Dryland has been active in engineering society affairs in England. He is a member of the Institution of Civil Engineers, past-president of the County Surveyors Society, member of the council of the Institution of Municipal and County Engineers, member of the council of the Institute of Transport, and has served as a member of the engineering advisory committee of the British Road Board, the predecessor of the Ministry of Transport.

Leland, Not Lekinol

Through a typographical error, the name of the dean of the college of engineering, University of Minnesota, was given in *Engineering News-Record*, Sept. 1, 1921, p. 379, as O. M. Lekinol. The name should have been O. M. Leland, newly appointed a commissioner for the Costa Rica and Panama boundary.

Cable Erection For First Suspension Highway Bridge To Be Built By New York State—Rondout Creek Bridge at Kingston



With a channel span of 705 ft., the Rondout Creek bridge is 1,100 ft. long over all. It carries the main highway along the west bank of the Hudson River, replacing an ancient chain ferry. The deck, 22 ft. wide, is a reinforced-concrete slab on steel framing, designed for carrying the heaviest trunk-line highway traffic.

Two 9-in. parallel-wire cables are the main supporting members. The photo, taken ten weeks ago, shows the start of their construction, temporary footwalks for the cable-spinning having just been placed. At present the cables are completed and the suspenders are being hung.

The bridge will cost about $700,000. Daniel E. Moran is consulting engineer for the foundations, and William H. Yates for the superstructure. Terry & Tench, Inc., are the contractors; Holton D. Robinson is their consulting engineer and W. L. Jordan their field superintendent. The work is being done for the state highway commission. Herbert S. Sisson, commissioner, and F. W. Sarr, first deputy. The department's engineers in charge are James H. Sturdevant, division engineer, and W. E. Joyce, resident engineer.

Philadelphia Engineers' Club To Discuss City Paving

A two-day meeting to discuss the general subject of city paving, in which the cities of Philadelphia, Baltimore, and New York, University of Pennsylvania, and the Philadelphia Chamber of Commerce will be represented, will be held at the house of the Engineers Club of Philadelphia, 1317 Spruce St., Oct. 20 and 21. Morning, afternoon, and evening sessions will be held on each day. The meetings will be devoted to a consideration of administration, repairs and maintenance, new pavements, and foundations.

There will be two principal speakers for each session and their papers will be prepared, printed, and distributed in advance so far as possible. Synopsis of these papers will be read, occupying not more than 15 to 20 min. each, to be followed by verbal discussions limited to 5 or 10 min. per speaker.

Snare & Triest, Old Contracting Firm, Changes Name

The Snare & Triest Co., contracting engineers, New York City, announces a change in its firm name to the Frederick Snare Corp. No recent change has been made in personnel, the latest changes having been noted in an issue of *Engineering News-Record* several months ago. The Snare & Triest Co. has been operating for twenty years in practically every branch of construction work, though its specialty has been port and terminal development work and large industrial plants.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, New York, N. Y.; Semi-Centennial Anniversary, Wilkes-Barre, Pa., Sept. 12-15.

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Convention, Bridgeport, Conn., Sept. 13-16.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Valparaiso, Ind.; Annual Convention, Baltimore, Md., Oct. 24-28.

CITY MANAGERS ASSOCIATION, Spartanburg, S. C.; Annual Meeting, Chicago, Nov. 14-16.

NATIONAL MUNICIPAL LEAGUE, New York City; Annual Meeting, Chicago, Nov. 16-18.

The Kansas Engineering Society will hold its next meeting at Hutchinson, Kan., Dec. 22 and 23, 1921.

The Brooklyn (N. Y.) Engineers' Club will celebrate its twenty-fifth anniversary at a dinner to be held in the Chamber of Commerce, 32 Court St., Brooklyn, Oct. 8.

PERSONAL NOTES

CHARLES M. LEWIS, division engineer of the Erie R.R. at Susquehanna, Pa., has been transferred to Jersey City, N. J., and will have jurisdiction over the New York division and side lines, including a part of the New York, Susquehanna & Western division.

F. O. ROSE, formerly structural draftsman with Stone & Webster, Boston, has accepted a similar position with the Southern California Edison Co., Los Angeles.

A. M. SMITH, designing engineer in the bridge department, Canadian National Rys., has been transferred from Winnipeg to Toronto.

E. I. ROGERS, formerly roadmaster of the Iowa division, Illinois Central R.R., has been appointed chief engineer of the Peoria & Pekin Union Ry., with headquarters at Peoria, Ill.

ERWIN E. TRUEBLOOD, for 15 years connected with the Missouri Valley Bridge & Iron Co., Leavenworth, Kan., has been appointed county engineer of Douglas County, Kan.

W. H. SCHIMMEL, formerly engineer maintenance of way, Monongahela Valley Traction Co., Fairmont, W. Va., is now chief engineer of the Keeley Construction Co., Clarksburg, W. Va.

DUDLEY & GLEASER, Manchester, N. H., is a new firm of consulting civil engineers recently organized by Arthur W. Dudley, who has specialized in water-works construction throughout New England for about 35 years, and Frederick Gleaser, formerly landscape engineer and superintendent of parks for the City of Trenton, N. J., and, at one time, section engineer for the Board of Water Supply of the City of New York on the construction of the Kensico dam and reservoir. The firm will specialize in water-supply and sewerage design and construction.

R. S. TOUR, chemical engineer of the nitrate division, Ordnance Department, U. S. Army, has been made dean of the department of chemical engineering, University of Cincinnati, Ohio.

PROF. DAVID FRIDAY, of the economics department of the University of Michigan, has been elected president of Michigan Agricultural College, East Lansing, Mich.

DEWITT V. MOORE, engineer and contractor, Indianapolis, has been made secretary of the newly appointed Engineers' Registration Board of Indiana.

C. H. PAUL, assistant chief engineer of the Miami Conservancy District, assumes on Sept. 1, the position of chief engineer. Announcement of this change was made some time ago. Arthur E. Morgan, formerly chief engineer, now acts as consulting engineer.

FRED J. POSTEL, supervising engineer, Illinois Department of Public Works and Building, has resigned and returns to consulting engineering practice as head of F. J. Postel & Co., Chicago. Mr. Postel withdrew from active participation in the affairs of the company during his four years' service for the state. His department has been consolidated with the architectural division. The work of the two offices is under the direction of the supervising architect, Edgar Martin.

DAVID C. FINSTON, formerly resident engineer with the American Pipe & Construction Co., Philadelphia, has opened an office in that city for the practice of engineering and surveying.

J. GARDNER BENNETT, instructor of civil and municipal engineering in the extension division, University of Wisconsin, has been appointed city manager of Fort Myers, Fla. Mr. Bennett is a graduate of Cornell College, Iowa, and of the University of Wisconsin. He was the unanimous choice of the commission from more than 100 applicants.

R. C. E. WEBER, assistant engineer, Orland project, U. S. Reclamation Service, has been made project manager. Mr. Weber has been with the service since 1907, spending all but the first year on the Orland project.

J. W. WILLIAMS, who has been chief engineer of the Northwestern Pacific R.R. since 1907, has resigned to become chief engineer of the Western Pacific R.R. The announcement of this change was made at a dinner tendered Mr. Williams by the officials of the Northwestern Pacific Railroad Co. and which was attended by all the executive officers from the president down. Mr. Williams began railroad engineering work with the Santa Fé in 1903 and continued with that company until 1907, when he became assistant chief engineer of the Northwestern Pacific. In May, 1917, he was commissioned a major and assigned to the 18th Engineers. He was advanced to the rank of lieutenant colonel and served with the same regiment in France until his discharge in July, 1919. On leaving the army he was made chief engineer of the Northwestern Pacific Railroad in charge of construction, maintenance and operations.

CHARLES W. MURRAY, formerly city engineer of Miami, Fla., has been appointed acting director of the Department of Public Service, Miami, Fla.

BARTO-PHILLIPS CO., engineers and builders, New York, has been organized by Edmund L. Barto and Harry J. Phillips, formerly sales engineer and chief engineer respectively of The Austin Co., New York, to engage in the engineering design, construction and exportation of all classes of industrial buildings, including power house equipment requirements.

W. E. HOBBS, surveyor for the Manitoba Good Roads Board, has been appointed controller of town planning for the provincial government of Manitoba.

BEN BLOW, for many years manager of the good roads bureau of the California State Automobile Association, has been appointed manager of the Victory Highway Association, which proposes to erect suitable monuments on a transcontinental route that will be dedicated to American heroes of the world war. Mr. Blow has taken an active part in state and county highway bond campaigns and is said to be California's most successful manager of campaigns of that sort. He is the author of "California Highways," reviewed in *Engineering News-Record*, June 17, 1920, p. 1216.

G. H. HICKS, who has been connected with the Northwestern Pacific R.R. since 1912 as valuation engineer and later as principal assistant engineer, has been appointed acting chief engineer.

A. N. BURCH, project manager, Orland project, U. S. Reclamation Service, has resigned. He has been in the service since 1908. After one year on the Umatilla project he went to Orland, first in charge of preliminary surveys and designs of the distribution system and since 1910 as project manager.

OBITUARY

ANGUS SINCLAIR, civil engineer and railroad contractor, died in Toronto, Ont., Aug. 24. He was born in Chatham, N. B., in 1848. For a time he was on the staff of the Intercolonial Ry., and in 1875 went with the Canadian Pacific Ry. at Port Arthur, Ont. Three years later he engaged in railroad contracting and built many sections of the Canadian Pacific and Canadian Northern systems. He also served on the construction of the Mt. Royal tunnel at Montreal.

BUSINESS NOTES

THE COCHRANE STEAM SPECIALTY CO. of Massachusetts has been organized, with offices in Boston, Mass., to represent in New England a number of well-known manufacturers of power-plant equipment, including the H.S.B.W.-Cochrane Corp., manufacturers of feed water heaters, meters, etc.; the Steam Motors Co., Inc., manufacturers of steam turbines for driving generators, etc.; and the D. Connelly Boiler Co., buliders of water tube steam boilers.

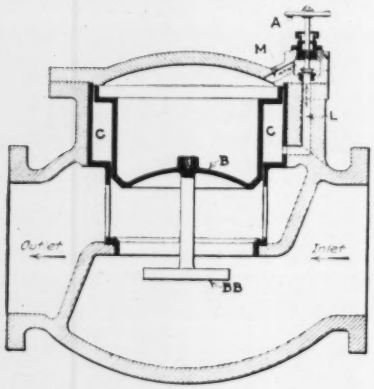
J. D. ACKENHEIL, formerly with the Portland Cement Association as field engineer in the Pittsburgh district, has been appointed special representative for the Heltzel Steel Form and Iron Company, of Warren, Ohio. He has had special experience in the use of steel forms for road work and has had general supervising charge of a number of important highway jobs.

EQUIPMENT AND MATERIALS

Automatic Double-Cushioned Check Valve

An automatic double-cushioned check valve, particularly adapted for use in discharge line of pumps to prevent disastrous back flow when the pumps are suddenly shut down, is being put upon the market by the Golden-Anderson Valve Specialty Company, of Pittsburgh. It is furnished in either angle or globe pattern up to 24 in., inclusive, and, in addition to the hand control here shown, may be furnished with electrical control.

The diagram shows the value in open position. Should there be a reversal of flow the pressure acting on the piston *BB* forces the main piston *B* to its seat. Meanwhile, the pressure accumulating in the annular chamber *C* is forced through the ports *L* and *M* to the top part of the valve chamber, thus



effectively cushioning the valve in closing.

When the valve is in the closed position, on the other hand, the pressure acts upward on the bottom of the main piston *B* and the flow through the ports *M* and *L* is reversed. The small control valve *A* is for the purpose of setting the speed of the valve to suit the requirements.

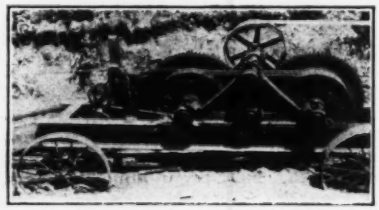
A New Metal Lath

A new product called "Diamond Rib" lath has been developed by the General Fireproofing Co., Youngstown, Ohio, for use in suspended ceilings or walls and in connection with steel tile and steel lumber floor construction. The new product is similar to "Self-Sentering" and contains the "Self-Sentering diamond mesh, stiffened by cold-drawn U-shaped ribs 4.8 in. on centers and approximately ⅜ in. in height. The mesh forms a base and key for plaster, while the ribs give the strength necessary to stand a wider spacing of supports than is common with ordinary flat lath.

All sheets are 24 in. wide and in standard lengths of 8 ft., and can be furnished in 24, 26 and 28 gages.

Cable-Pull for Road Grading

A simple mechanism for operating an endless cable, pulling scrapers for handling earth, is shown by the accompanying illustration. From the machine, the endless cable runs across the fill area to the hill where the cut is to be made. The 7-cu.ft. slips are attached to the cable with a grab. They are drawn by the cable to the loading

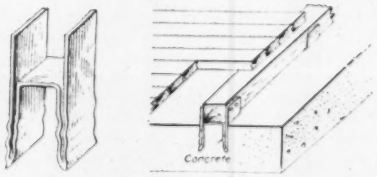


point, detached and sent back filled on the return cable.

The machine is the invention of P. M. Caldwell and W. H. Salyers, of Malvern, Iowa, and has been used on a number of earth-moving jobs.

New Floor Clip Appears

A construction engineer of several years' experience has recently invented what is known as a bulldog floor clip, shown in the accompanying view, and which is about to be put on the market by the Bulldog Floor Clip Co., Winter-



set, Iowa. The clip is designed to hold the floor strip down to a concrete slab without the use of concrete in between the floor strips. Not only is the fill ordinarily used eliminated, but an air space is provided that minimizes the chance of dampness or dry rot.

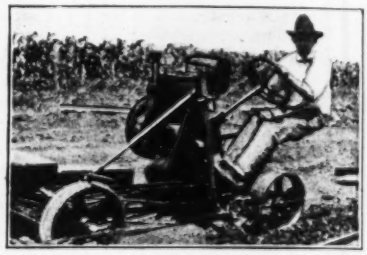
Company Donates Machine for Cleaning Up Pueblo

Immediately upon hearing of the disaster at Pueblo, the Pawling & Harnischfeger Co., of Milwaukee, decided to send one of their full corduroy traction excavator cranes to assist in the relief work. The excavator was sent on a special car and with the assistance of the railroad companies and the Pueblo city officials was put through in quick time. The machine is equipped with a clam-shell bucket and is moving a tangled mass of debris consisting of mud, wagons, trees, telegraph poles, telegraph wires, lumber—in fact all of the varied wreckage that follows in the wake of a flood. Two steam shovels are also included in the removal equipment and altogether about 250 men have been engaged on the clean-up work.

Cuts Grade for Road Forms

The grade for road forms is prepared at the rate of 300 to 700 ft. per hour by the form-grading machine illustrated. Guided by a cord stretched between grade stakes, the machine is almost perfectly accurate when driven by a careful operator. It trims a strip 8 in. wide, thus giving ample room for lining up forms with a 4-in. base. It will cut to a depth of 5 in., but ordinarily, on well-prepared grade, the cut is shallow, the grade merely being trimmed precisely to profile.

The grader has a 4-ft. 10-in. wheelbase, 4-ft. gage, and weighs about 1,250 lb. The construction is particularly accurate, embodying automobile axles and hubs, cut gears, standard chain belts and automobile parts wherever possible. Foot treadles steer the machine and the handwheel lifts and lowers the cutter. The motor is a New Way 5-hp. gas engine. There are two



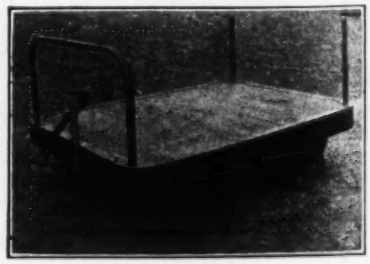
speeds cutting, traveling and in reverse. A traveling speed of 4,000 ft. per hour is possible.

Several form graders are in operation on concrete road work in Illinois and are stated to be a success. They are manufactured by Edward G. Carr, 224 W. Huron St., Chicago, Ill.

Trailer for Warehouse and Terminal Service

A trailer, known as the "Brute," designed for heavy duty service with tractors in warehouses, terminals and transfer stations, has been put on the market by the Sharon Pressed Steel Co., of Sharon, Pa. It is made in lengths up to 72 in., and in width up to 50 in.

The front wheels are castered, and all wheels have roller bearings. The frame supports are flush on the bottom, thus affording an even support



when the trailer is used in connection with a lift truck.

The trailer was recently given a road test carrying a load of 8,000 lb., and revealed no weakness.

Business Side of Construction

Facts and Events that Affect Cost and Volume

San Francisco Building Situation Clears Up

By a vote of two to one, unions affiliated with the Building Trades Council in San Francisco on Aug. 27 voted officially to end the strike without formal terms. At the same time the vote was five to one against adoption of the American plan, which is in effect on many San Francisco jobs and which involves the employment of both union and non-union men in the same shop.

Another recent development in the building trades controversy was the court action dismissing the charges against George and Gompertz, officials of the Builders' Exchange, who had been accused of conspiring to withhold building materials during the strike. The evidence showed, the court ruled, that the combination of material men and building employers was not formed in restraint of trade but solely to accomplish certain results in a labor dispute. Labor disputes, it was pointed out, are not within the contemplation of the Cartwright act (the California statute that corresponds to the Sherman act for interstate cases).

In the decision the court quoted the district attorney's opinion that any individual may refuse to sell his merchandise to anyone whatsoever. "If he may refuse to do so individually," the decision continued, "he may refuse to do so in combination with others if such act is in contemplaton or furtherance of a trade dispute."

In the meantime the Industrial Association of San Francisco has laid out a plan of action for seeing to it that industries are not interfered with by labor disturbances without proper consideration of the three interests concerned—the public, the employee and the employer.

Previous references to the San Francisco building strike and the adoption of the American plan appeared in *Engineering News-Record*, July 21, 1921, p. 128, and Aug. 11, 1921, p. 259.

Federal Recognition Given to Portland Exposition

Among the bills signed by the President just before the Congressional recess last month was the one authorizing the President to invite foreign nations to participate in the exposition to be held in Portland, Ore., in 1925 to celebrate the centennial of the invention of the electromagnet, the completion of the transcontinental and Pacific highways and to exemplify the development of hydro-electric energy.

In order to handle the affairs of the exposition in a business-like way, a corporation has been organized with a capital stock of $5,000,000, whose directorate is composed of thirty-three leading Northwest business men.

Car Loading

An increase of 7,471 in the number of cars loaded with revenue freight during the week which ended on Aug. 30, compared with the previous week, was shown by reports just received by the car service division of the American Railway Association. The total for the week was 816,436 cars. In the following table is given a comparison with the car loading for the week ended Aug. 30, 1921, as compared with the corresponding week of 1920:

Classification	1921	1920
1. Total	816,436	968,103
2. Merchandise and miscellaneous freight	491,922	534,922
3. Live stock	29,110	27,110
4. Coal	154,140	204,140
5. Grain and grain products	59,875	41,638

Retail Food Prices Increase

The U. S. Department of Labor, through the Bureau of Labor Statistics, has completed the compilations showing changes in the retail cost of food in August, in fourteen cities of the United States. During the month from July 15 to Aug. 15, there was an increase in all of these cities. In Philadelphia there was an increase of 6 per cent; in Bridgeport, Chicago, New Haven, Providence, and Washington, 5 per cent; in Kansas City, 4 per cent; in St. Louis, Springfield, Ill., and Birmingham, 3 per cent; in Peoria, 2 per cent; in Salt Lake City, Denver, Little Rock, 1 per cent.

As compared with the average cost in the year 1913, the retail cost of food on Aug. 15, 1921, showed an increase of 66 per cent in Washington, 64 per cent in Providence; 61 per cent in Chicago; 55 per cent in Kansas City and Birmingham; 54 per cent in St. Louis; 53 per cent in New Haven and Philadelphia; 44 per cent in Little Rock; 42 per cent in Denver; and 35 per cent in Salt Lake City.

Material Dealers in Buffalo Indicted

Indictments were returned last week by the extraordinary grand jury of the supreme court against eleven firms and ten individuals dealing in masonbuilding supplies in and near Buffalo, New York. The defendants are charged with violating the state antitrust laws in that it is alleged they entered into an agreement whereby the prices of about 90 per cent of the lime, plaster, cement, hydrated lime and other materials used in that territory, were controlled. The report of the grand jury is the fourth one made in connection with an investigation of the building industry in Erie county.

Attorneys representing the defendants entered pleas of not guilty. Bail, in the case of the ten individuals, was set at $2,000.

Outside Builders Received in Chicago

Recent press reports are to the effect that the building industry in Chicago and Cook county, practically closed to outside contractors, has been thrown open as a result of a recent suggestion of Judge K. M. Landis, who has acted as arbitrator in the disputes arising in that city in the building industry. In agreeing to meet any and all competition openly the only stipulation made is that outside contractors become members of either the city or the county organization of employing builders.

Seattle Raises Its Quota of Funds for Columbia River Bridge

By raising $40,000 through subscriptions by business men Seattle has contributed its quota of the $400,000 needed to construct the proposed Kennewick-Pasco toll bridge across the Columbia River. Plans for the structure are now in preparation in the office of the Union Bridge Co., of Seattle, and it is believed that construction will start this month. The new bridge will obviate the present necessity of tourists taking a ferry, which has kept thousands of tourists off the Yellowstone trail. It will consist of 1,410 ft. of steel structure and about 1,800 ft. of timber structure, and is to carry a 20-ft. roadway. It was originally intended to pave the bridge with concrete, but this idea has been temporarily abandoned.

Quantities included in the proposed structure are 1,000 tons of steel, 7,000 cu.yd. of concrete, and 1,000,000 ft. of lumber. Boring at the pier sites have been completed.

Car Priority Order Protested

In a letter recently sent out to associations interested in construction and to the Interstate Commerce Commission, R. C. Marshall, Jr., general manager of the Associated General Contractors of America, raises a protest against the possible reinstitution of car-priority orders. In his letter he refers to the opinion recently expressed by the Geological Survey and the American Railroad Association that a shortage of open-top cars is liable to result from any sudden revival in industry.

"Last year's disaster," runs Mr. Marshall's letter, "did happen and will doubtless happen again should priority be reinstituted. Therefore, in order to provide against this contingency, it is essential that no priority shall be established without due regard for the rights of each industry involved."

It is the assertion of Mr. Marshall that millions of dollars were lost to the construction industry last year through inability to move materials though

these construction firms were bound to both private and governmental agencies by rigid contracts which penalized them for delayed completion.

The possible loss to construction companies of money is not the only consideration, Mr. Marshall finds. He asserts that if any priorities were established the construction industry should be one of the first to be considered inasmuch as the country is so short of housing facilities, and inasmuch as the need for construction work of all kinds is so general.

Illinois Has Awarded 283 Miles of Hard-Surface Paving

Up to and including Aug. 20 the Illinois Division of Highways, Department of Public Works and Buildings, had let during 1921 contracts for the construction of 282.69 miles of hard-surface roads. In addition to this amount it is expected that contracts will soon be let for the construction of 87 miles.

Besides the paving work, the Illinois Division of Highways has let contracts this year for 265.24 miles of heavy grading, the cost of which is $1,247,229. Contracts for 65 bridges have also been let, the total cost of which amounts about $850,000.

Though no definite program of accomplishment for the 1921 construction season had been decided upon by the state highway engineer, a tentative outline of a possible 500 miles was had in mind early in the year. About 75 per cent of that amount will have been finished by the end of the current calendar year.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted. The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of September 1, the next, on October 6.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$2.88	$3.50	$4.00	$2.88	$3.16	−$4.00	$3.70	$4.00	−$4.00
Structural rivets, 100 lb.	−3.70	5.25	5.50	−3.68	−4.15	4.25	5.50	5.25	−6.50
Reinforcing bars, ¾ in. and larger, 100 lb.	2.78	3.20	3.50	2.78	3.18	−3.57½	2.35	3.75	−3.75
Steel pipe, black, 3½ to 6 in. lap, discount	51%	52.65–5%	45%	+48½%	53.9–5%	36%	46.25%	−48½%	5%
Cast-iron pipe, 6 in. and over, ton	−43.30	43.33	53.30	−45.60	−50.80	57.50	60.00	−60.00	−70.00
Concreting Material:									
Cement without bags, bbl.	2.60@2.70(del.)	2.75	2.80	2.17	2.41	3.10	3.09	3.10	3.10
Gravel, ¾ in., cu.yd.	2.25	2.25	3.00	1.80	2.00	2.50	2.25	1.50	1.50
Sand, cu.yd.	1.25	1.35	2.50	1.80	1.00	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	−1.80 to 1.90	2.25	2.80	2.00	2.25	3.50	2.25	3.50	2.10
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	45.00	38.00	35.00	−46.00	34.00	49.00	30.00	21.50	120.00
Lime, finishing, hydrated, ton	16.99	19.00	25.00	20.00	29.00	30.00	25.40	24.00	−21.00
Lime common, lump, per bbl.	3.69	1.50	2.75	1.65	1.50	2.95	2.25	2.75	15.00
Common brick, delivered, 1,000.	+18.40@19.40	10.00	12.72	11.00	17.00	14.00	18.00	14.00	−16.00
Hollow building tile, 4x12x12, block	Not used	.14	.124	.0926	.092	.09	.12½	.11	.15
Hollow partition tile 4x12x12, block	+.11370	.14	.124	.07410	.092	.10	.14½	.12	.....
Linseed oil, raw, 5 bbl. lots, gal.	−.78	.86	.98	+.87	.90	.98	.95	.79	+.86
Common Labor:									
Common labor, union, hour	.75@.80	.35	.....	1.00	.50	.50@.63½	.81½	.75	.....
Common labor, non-union, hour	.....	.20	.35@.45	.40	.50	.37½@.50	.50@.55	.50	.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or − signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent, 45@50 means a range of 45 to 50 per cent. Charge of 15c. per 100 lb. for cutting reinforced steel into 2-ft lengths or over. **New York** quotations are delivered except tiles, which are "on trucks." Common lump lime per 280-lb. net; both lump and hydrated quoted f.o.b. cars New York. Sand gravel and crushed stone are quoted alongside dock. **Chicago** quotes hydrated lime in 50-lb. bags. **Minneapolis** quotes on fir instead of pine. Brick and hollow tile delivered. Cement on cars; $2.60 delivered. Gravel, sand and crushed stone quote at pit. We quote on brown lime; white is $1.80 for Kelly Island and $1.65 for Sheboygan. Common labor not organized. **Denver** quotes cement "on tracks"; gravel and sand at pit, stone on cars, lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered. **Atlanta** quotes sand, stone and gravel per ton instead of cu.yd. **Dallas** quotes lime per 180-lb. bbl. Steel, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. **San Francisco** quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Lumber prices are delivered "at ship tackle in San Francisco ex mill." **Seattle** quotes on Douglas fir instead of pine; and on lime in paper bags. **Montreal** quotes sand stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. Cement price is in Canadian funds, exchange with the United States being 14 per cent at present. Bag change is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment.

Changes Since Last Week

Structural steel shapes have been quoted in Pittsburgh as low as $1.70@$1.75, with soft steel bars at $1.60@$1.70 per 100 lb. New York quotes mill shipments of structural shapes at $2.13@$2.23; bars at $2.08. Structural rivets are quoted at $3.70 as against $4.40, at New York warehouses.

Denver reports mill price of steel shapes at $3.24½ including freight and war tax; stock and warehouse price $4 as against $4.10. Reinforcing bars are quoted at $3.57½ as compared with $3.97½ previously. Sharp decreases in structural rivets are shown in New York, Chicago and Minneapolis. Mill shipment price, in Seattle, of steel shapes is $75.20 and the stock price $110.20 per ton. Mill shipments, Minneapolis, are quoted at $2.51, all rail; $2.45 per 100 lb. lake and rail. Steel pipe has advanced in Chicago and declined in Seattle. Decreases ranging from $2 to $5 per ton in cast-iron pipe prices are reported in New York, Minneapolis and Seattle. Chicago price has been reduced from $46.10 to $45.60 per ton.

Market for concreting material remains firm throughout the country. New York reports a reduction of 10c. on crushed stone, making the present price $1.80@$1.90 as compared with $1.90@$2 per cu.yd. formerly. This reduction has been made possible by economies having been effected in delivery methods.

Chicago reports the only reduction in lumber prices; quoting pine, base size, at $46 as against $49 per M ft. b.m.

An advance of $1 in the price of common brick is shown in the New York market; the present quotation being $18.40@$19.40 per 1,000, delivered. The demand for common brick still continues in the New York district with the price but little in advance of the cost of production.

Hollow partition tile has advanced slightly in New York and dropped in Dallas, during the last two weeks.

Linseed oil has advanced 7c. in Chicago and 2c. per gal., in 5 bbl. lots, in Montreal.

Common labor, non-union, is available in Montreal at 20c., as against the regular schedule of 30c. per hour.